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SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING

OCTOBER
1959

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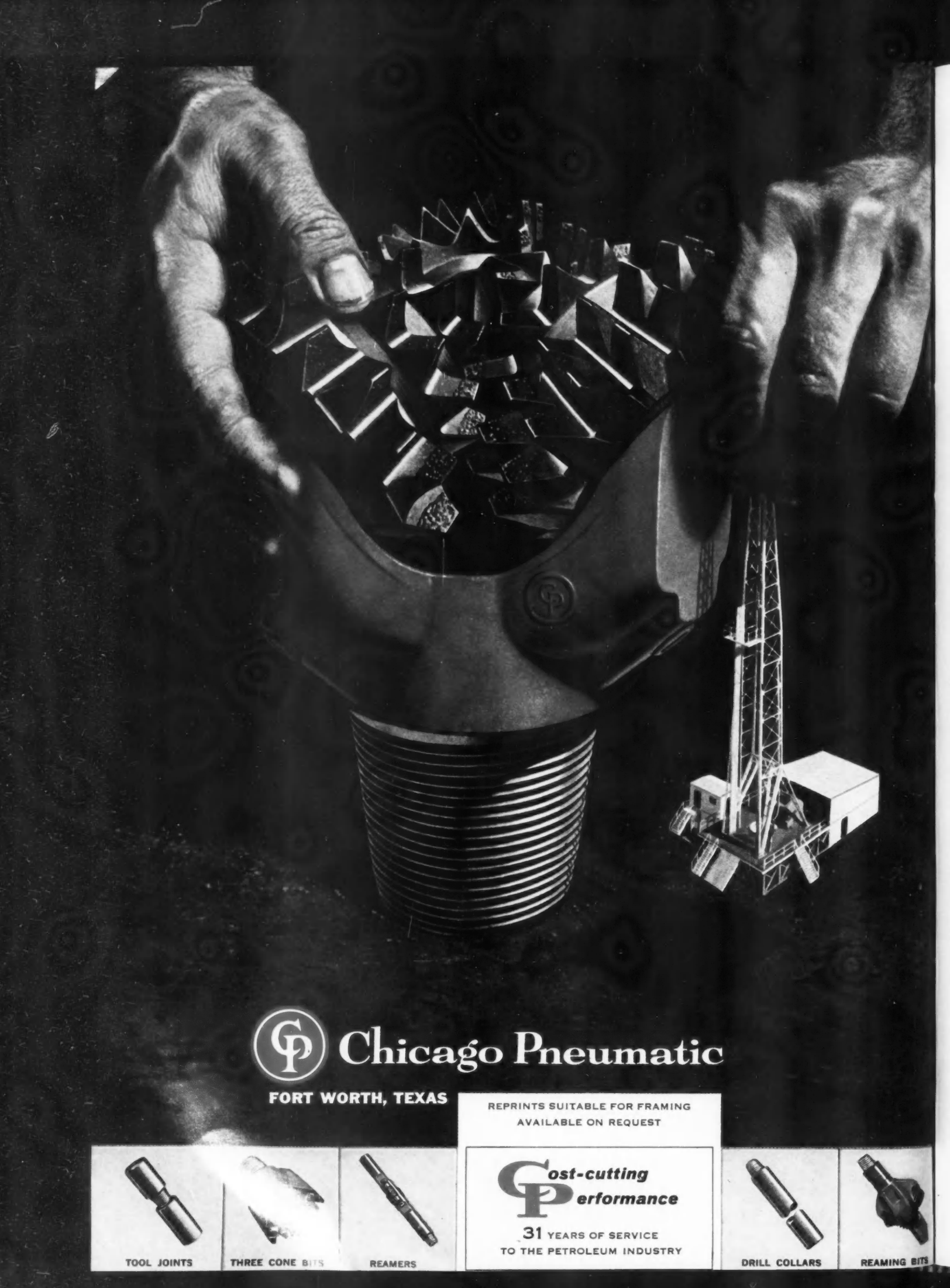
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VOLUME 149, NO. 5 OCTOBER, 1959

WORLD OIL

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SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

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Drilling Progress '59

pages 95-127

Rising costs . . .
Tight profit margins . . .
Need for better trained personnel . . .
How to drill deeper holes faster and cheaper . . .

These are just a few of the serious, immediate problems facing the drilling phase of the oil industry as it enters its second century of existence. The manner in which these problems are met, and solved, may well determine the future progress of the industry.

As a special service to those whose future depends on drilling, Engineering Editor Jack F. Earl and other members of the WORLD OIL staff have spent the past 12 months planning, researching and traveling thousands of miles to obtain authoritative and informative answers to current drilling industry problems. Their aim was to provide WORLD OIL readers with the most complete, factual drilling progress report published to date.

That aim has been accomplished. In the 33 page report starting on Page 95, you will find full coverage of the following subjects:

- Drilling Economics—Present and Future
- What Can be Done to Cut Drilling Costs
- Newest Land and Offshore Drilling Methods
- How Rigs Are Being Equipped for Alaska
- Latest Developments in High Temperature Muds

Extra copies of the Drilling Progress Issue are 50 cents each.

a Quick Look at this issue . . .

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first

☐ **Can the earth's "crust" be penetrated? . . .** After several months of intensive research, sponsoring groups believe it is entirely feasible to set up a drilling operation in 10,700 feet of water, then drill more than four miles through the earth's crust to the Mantle. Most promising site to date is an area between Guadalupe and Clipperton Islands west of Mexico. For the first official report on the "Mohole" Project, including ways in which oil industry know-how and equipment can be used, benefits to be obtained and problems to be solved, turn to Page 128.

☐ **Why not store offshore oil in salt domes? . . .** A recent survey has confirmed that storage of offshore oil in centrally located salt domes off the Louisiana coast is technically and economically feasible. Salt cavity wells (similar to LPG and gas storage facilities now in use) would be leached in the domes. The technique would reduce operating and storage costs and eliminate weather as an adverse production factor. For additional information on this unique procedure, see Page 132.

☐ **South Michigan's oil bonanza . . .** Three south-central Michigan counties currently are the scene of one of the hottest oil plays east of the Mississippi River. Efforts to prove up a Trenton-Black River trend already have produced three promising oil fields, and possibilities are good that adjacent trends will be found.

For a detailed description of activity to date, geology, drilling and production data, plus two maps of the area, turn to **Page 136.**

☐ **How through-tubing bridge plugs work . . .** Development of the drillable through-tubing bridge plug has been an additional step toward reducing well recompletion costs. Bridging tools are run through tubing and set in casing. Cement is deposited to a desired height on top of the tool by a small o.d. dump bailer. Jobs can be completed in 24-30 hours and have been performed successfully on wells as deep as 11,000 feet. Rigs and pumping equipment are not required. For a complete description of the four types of bridge plugs available commercially, and how they are used, see **Page 141.**

☐ **Clay sedimentology can be useful exploration tool . . .** These new applications of clay studies offer great promise in oil exploration work. However, there has been some confusion about the significance of such data. This article re-examines highlights of recent clay studies and emphasizes their importance to the industry . . . **Page 150.**

☐ **New interest develops in Argentine oil basins . . .** The southernmost South American nations, Argentina, Uruguay and Chile have oil possibilities varying from fair to excellent in a number of widely-scattered regions. The potential of western Paraguay is considered good. This article, illustrated with generalized sedimentary columns for each of the main areas of interest, is the second of an exclusive WORLD OIL series devoted to South American prospects . . . **Page 155.**

☐ **Here's how to improve your gas lift installations** (Part 3) . . . A new, simplified gas lift valve spacing chart for low productivity intermittent wells permits operators to quickly design suitable valve installations in the field when little or no data are available for more precise calculations. Proper application of the chart can result in time and money saved. See **Page 159.**

☐ **How to evaluate cuttings in air and gas drilling . . .** Microscopic study of cuttings from air and/or gas drilled wells provides ample data on shows and lithology, particularly when corroborated with surface evidence such as gas input-output relationships,

Continued on Page 6

Oil Industry In Brief

Here are the latest economic trends, revealed by WORLD OIL *and industry research:*

On the plus side

Demand future bright. Demand for all oils continues 4 to 5 percent above last year . . . **See Page 25.**

Stronger markets ahead. With imports and stocks being held within reasonable limits, outlook brightens for markets and prices—may well gain strength in coming months . . . **See Page 25.**

Crude stocks down. At August's end, crude stocks had been cut to 252.9 million barrels, a drop of 10.8 million barrels or 348,300 daily from July 31 totals . . . **See Page 25.**

Wildcatting increases. Operators drilled 6,416 wildcats during first eight months of 1959, 0.8 percent more than were completed during same 1958 period . . . **See Page 28.**

More footage drilled. During first eight months, footage drilled totaled 129.7 million feet, up 4 percent over same 1958 period . . . **See Page 28.**

On the minus side

Steel shortage here. Steel pinch is being felt in oil country tubular goods. High grade tubing already is in short supply—and will not be readily available at least until next March, even if mills resume operations immediately . . . **See Page 13.**

Tight money hurts. Money shortage will hit industry expansion in coming months. Some companies already are limiting expenditures to amounts available from depreciation schedules and net income.

California prices weak. Imports from Canada have combined with upswing in natural gas from Southwest to put serious dent in California crude prices. Union, General Petroleum and California Standard have cut prices 5-50 cents per barrel for various crudes. Others expected to follow suit.

QUICK LOOK at this issue . . .

circulating pressures, and drilling times. Different types of sample traps for specific situations are illustrated and described on . . . **Page 162.**

☐ **How to produce low gravity, viscous crude . . .** Economic production of heavy crude is a challenge for most operators, since potential recovery of such oil often is low. However, use of bottom-hole heaters, proper pumping procedures and treating methods peculiar to such crudes have helped to solve low gravity, viscous oil production problems, and also have reduced operating costs. For a complete discussion of these procedures and how they are used in the recovery of heavy crude (15 gravity and heavier), see **Page 172.**

☐ **Displacement methods for multiple tubing string wells . . .** On completion, operators currently use four general methods to displace drilling fluid from wells equipped with multiple strings of tubing. Variations of these methods also are used, depending on type of well-head, type down-hole equipment and operator preference. For a discussion of these general displacement techniques and how each is applied to multiple completions, see **Page 192.**

Why Oil Men Are Determined To Cut Costs

Next month, WORLD OIL subscribers will have a first-hand opportunity to read the most complete report on oil industry cost-price trends (and what can be done about them) yet published.

Here is what you will find in this exclusive special report:

- American Petroleum Institute and Independent Petroleum Association of America cost trends, with projections to 1970.
- Possible results of higher costs.
- Trends in prices compared with profits.
- Reasons for the current tight profit margins.
- What can be done to improve the industry's profit picture, including ways to improve operating efficiency.

And these are just a few of the timely economic subjects that will be covered. To make a long story short, your November "editorial bonus" will be packed with a host of helpful statistics and cost-cutting ideas—from the most authoritative sources.

Be sure to watch for the November issue. In fact, to keep completely and accurately informed on world oil affairs, read WORLD OIL every month.

WORLD OIL

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GPC PUBLICATIONS

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.
PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

Indexed by Industrial Arts Index and Engineering Index

Looking Ahead

Steel pinch is here . . . WORLD OIL survey of suppliers indicates following status of oil country tubular goods:

- Although tubing of all sizes and grades is becoming harder to get, an acute shortage of higher grades (N-80, P-105, P-110) already is plaguing the industry. Even if mills resumed operations tomorrow, it would be mid-November before appreciable shipments were sent out and mid-December before goods reached supply stores. Adequate supplies would not be available at least until next March.
- Also acute is supply of 4½-inch casing—and it will continue so for some time.
- H-40 and J-55 grades of casing, particularly 5½-inch, are not in too short supply as yet—should be in fairly adequate supply until January 1.

Hardest hit will be development drilling in deep areas, i.e., southern Louisiana.

Looking ahead in Washington . . . Ending its longest session in eight years, Congress adjourned last month leaving the oil industry more or less unscathed except for passing bill to hike federal gasoline tax to 4 cents per gallon for 21 months; however, watch for stepped up action on imports, depletion, fuels policy studies, natural gas controls during 1960 presidential election year . . . **Hearings on percentage depletion** have been changed from November 12 to December 1—at that time 10 panelists will discuss oil industry discovery and development costs . . . **Industry pressure is mounting** to speed new natural gas bill that will remove utility-like federal regulation of natural gas producers; may become important issue next year . . . **Federal Power Commission is requesting Presidential approval** of $156,000 hike in funds to $7.2 million so mountainous backlog of natural gas cases can be cut down a little.

What's ahead for oil? . . . Panel of industry experts took close look at future of energy resources during University of Houston's observance of oil's centennial last month: Their conclusions:

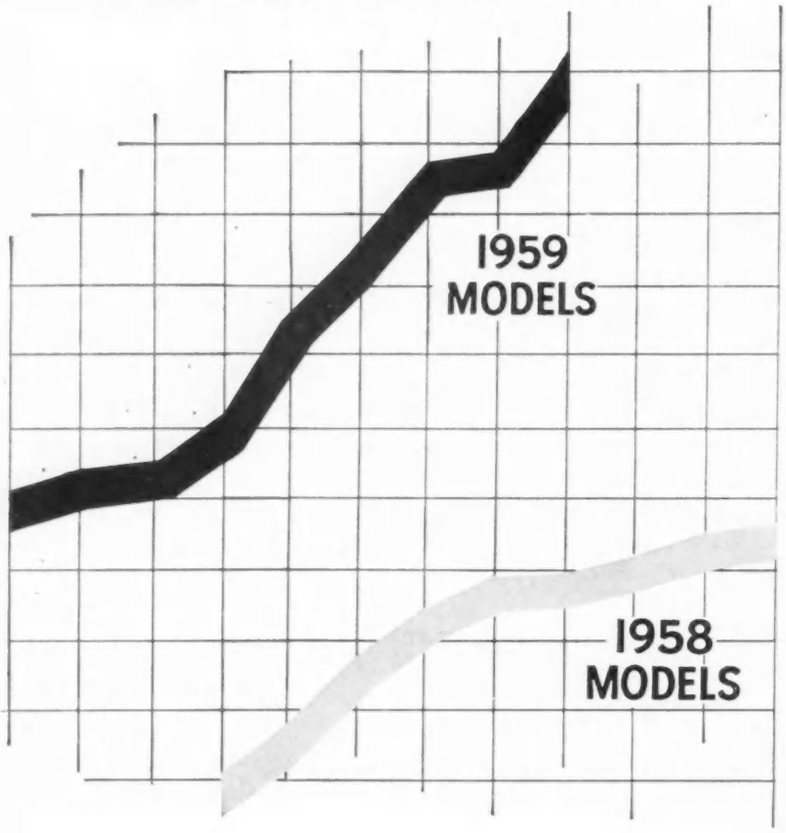
- Oil production will reach peak about year 2000, at which time about half the world's petroleum supplies will be exhausted.
- Ultimate U.S. production may be extended to 200 billion barrels by advances in secondary recovery techniques.
- Oil and gas will play major parts in world energy picture well into 21st century —coal reserves have a lifetime measured in centuries—energy from fissile fuels (uranium and thorium) will begin to be of great importance by 1990—commercial use of shale oil is not far off—use of fusion and solar energy are almost certainties, but not in immediate future.

Government oil company in Venezuela . . . Venezuelan national oil company may not be far off. President Betancourt claims new company would cause no conflict between government and private companies with investments in Venezuela. Then added, "The world's biggest petroleum exporter cannot continue without its own instrument for participating directly in the oil industry."

"Plowshare" budget restored by Congress . . . Senate has restored $2 million previously cut from project "Plowshare" for nuclear explosions in Colorado shale. Oil industry will contribute $500,000 for first part of experiment. Will provide another $700,000 to $1 million later for in situ combustion phase.

The BIG SUCCESS

1959 FORD SUPER DUTY TRUCK SALES MORE THAN DOUBLE THOSE OF LAST YEAR



1960 FORD SUPER DUTIES

SKYROCKETING SALES OFFER ADDED TESTIMONY TO THE TOUGHNESS AND RELIABILITY OF FORD "BIG V'S"— *NOW THEY'RE MORE DURABLE, MORE FLEXIBLE THAN EVER!*

Ford's increase in sales of Super Duty Trucks, while impressive in itself, by no means tells the whole story. Over half of the 1959 unit sales were the result of repeat orders from operators like Trucking Contractors, Inc., who bought because the Ford "Big V" provided the kind of performance and durability needed for their work.

And for 1960, the Ford Super Duties offer additional refinements designed to provide an even greater degree of dependability. Bigger optional axles and increased GVW's permit greater payloads and more profitable operation. Automatic radiator shutters to keep the engine temperatures within the most efficient operating range, submerged-type electric fuel pump to prevent vapor lock, and redesigned wiring for longer, more dependable operation are but a few of the improvements which add to the performance and durability of these units.

The changes offered for 1960 were tested and evaluated by America's foremost independent automotive research organization. The certified results of the studies by this impartial firm (name available on request) provide proof that Ford's Super Duty Trucks are even more dependable.

- **Certified Durability through closer temperature control!** Independent research engineers certify that Ford's thermostatically controlled radiator shutters kept water temperature between 168° and 188° in severe mountain grade operation. The test truck with shutters blocked open

of the Big Truck Field

"Tried 8 in '58—bought 20 more in 1959," says Curtis E. Brost, President, Trucking Contractors, Inc. "In 1958 we bought 8 Ford T-850's with lightweight chassis options and specially built 5-batch bodies which gave us a full extra batch per truck. A 5-batch load is a real strain on the truck when you consider we're 'running the ditches' on this highway paving job in North Dakota. These T-850's worked out so well that we ordered 20 more in '59. Our Ford Tandems with the 477 engine give us good mileage and the drivers are real happy with them. It's a rough go on trucks with soft footing and dust so bad we have to drive with headlights on. Despite such operating conditions, downtime has been negligible and these '477' Fords have given us less trouble than other trucks we have operated."

with Certified Durability

under same operating conditions had a temperature range from 102° to 181°. The temperature variation of only 20° with shutters means less expansion and contraction in engine block and cylinder heads. Higher temperatures with radiator shutters permit leaner fuel-air mixtures with less possibility of raw gas washing down cylinder walls. Warm oil circulates more freely, reducing internal friction. All these factors contribute to longer engine life.

- **Certified Dependability with longer-lived electrical system!** Ford's '60 improved wiring harness and the 1959 wiring harness were subjected to shaker table tests plus constant exposure to oil and water vapors and temperatures of 200°. Certified results prove that the greater resistance to deterioration by heat, oil, water and abrasion obtained with the 1960 wiring harness more than doubles wiring harness life.

- **Certified Reliability with Ford's submerged-type electric fuel pump!** Dynamometer tests of engines with submerged-type electric fuel pump and conventional mechanical type showed that vapor lock was non-existent with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical pump resulted in a power loss of 9% at an underhood temperature of 200°.

Test results like these plus the experience of satisfied users are important but that is not all. For 1960, the Super Duty line has been broadened to provide even more flexibility in power train options. Get the facts from your Ford Dealer!

FORD TRUCKS COST LESS

LESS TO OWN . . . LESS TO RUN . . . BUILT TO LAST LONGER, TOO!

For more data on advertised products, use Readers' Service Cards, last page.

Good Wells Make Good News

A Monthly Report on Wells That Are Now Worth More

October, 1959

Here are four recent examples of the many thousands of wells whose value has been increased with acid treatments performed by Dowell.

- **Hot Springs County, Wyoming** (New Oil Well) This well was completed into two sections of the dolomitic Madison lime. Perforations were from 4528 to 4558 feet, and from 4570 to 4584 feet. Since the lower section was more permeable, Dowell recommended acidizing it first and then plugging it off before acidizing the top zone. The bottom zone was treated with 750 gallons regular acid, tested at 16 boph, and temporarily plugged with 30 gallons of Jelly Seal. Then the upper zone was acidized with 3000 gallons acid with a demulsifying agent added. After clean-up the well tested 32 boph.

- **McPherson County, Kansas** (Water Injection Well) This well completed open hole into the Hunton lime would not take water at 500 psi. Dowell recommended a hot Stabilized Acid treatment using magnesium pellets as the heating agent. First, the zone was washed with 250 gallons of Mud Acid. Then 100 pounds of magnesium pellets were lubricated down tubing and filtered out on the formation face. 1000 gallons of Stabilized Acid were then injected slowly. One year later, the well was still taking more than 400 bwpd on vacuum.

- **San Juan County, Utah** (Old Oil Well) Production had declined to 200 bopd. Pay was the highly soluble Paradox between 5407 and 5581 feet. Dowell recommended a special acid treatment designed to establish a large drainage area throughout the pay. 40,000 gallons of Retarded Acid were injected in four 10,000-gallon stages. A total of 378 perforation ball sealers were used between stages. An injection rate of 25 bpm was maintained. After clean-up, well tested 700 bopd. Six months later it still tested 700 bopd.

- **Cass County, East Texas** (New Oil Well) The pay was a section of the Anhydrite between 6102 and 6111 feet. Potential was 80 bopd. Dowell recommended a three-stage treatment: First, 1000 gallons of acid with a silicate control agent added; then, 5000 gallons Retarded Acid with 18 perforation ball sealers; finally, 5000 more gallons acid with silicate control agent plus five more ball sealers. After clean-up, well tested 250 bopd.

Since well characteristics vary so widely, many operators find it pays to rely on Dowell's experience and engineering for the best possible results. For service or detailed information, contact the Dowell office or station nearest you. There are more than 165 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY

ABC + GPC = value for your money

ORDINARILY the above two symbols would be as out of place on WORLD OIL's editorial page as a rotary making hole on top of a cat cracker. But not this month.

During October more than 4,000 publisher, advertising agency and advertiser members will observe the 45th anniversary of the Audit Bureau of Circulations. This non-profit organization has become the publishing industry's most highly respected guardian of ethical standards governing audited circulation reports. Only publications with paid subscribers can belong.

Also, 43 years ago this month the first issue of *Gulf Coast Oil News* was published to mark the beginning of Gulf Publishing Company, which has become the largest specialized publisher serving the oil industry. Pardon our pride as we report that GPC's three publications, WORLD OIL, PETROLEUM REFINER and PIPE LINE INDUSTRY, have a combined circulation of more than 54,000 readers—nearly 9,000 more than any other weekly or monthly editorial effort to serve the same phases of the oil industry.

Gulf Publishing Company's success stems from three basic concepts:

1. Editorial quality builds paid circulation.
2. You, the reader, place value on what you pay for. Your decision to buy or not to buy a subscription reflects your judgment of the editorial quality of a publication.
3. Advertisers get the most for their money when they buy space in a specialized, audited, paid circulation publication.

The Audit Bureau of Circulations plays an important part in each of these concepts. The Bureau sets standards for the definition and measurement of paid circulation, verifies adherence to those standards through regular audits and furnishes circulation reports to each member of the organization.

These up-to-date, audited reports help advertisers to select publications that will give them the most for their advertising dollar.

When members of the GPC staff study the semi-annual circulation reports, they find out in a hurry if they are earning their keep, i.e., providing an editorial service that will maintain a growing list of satisfied subscribers. This, plus increased advertising sales, is the ultimate reward for editorial initiative and leadership.

You see, it's as simple as adding ABC and GPC. Combine the publishing industry's symbol of circulation authenticity with the oil industry's symbol of specialized editorial quality and the result is a publication that gives you full editorial value for your money.

A MESSAGE FROM BARNEY

ATTENTION ROTARY HOSE USERS

"We have a problem, and it's a big one!"

For the past ten years we have reconditioned GOODALL Rotary Hose here in our Houston plant and, from the reports of the drilling fraternity, saved this branch of the Oil Industry many, many dollars.

We are set up to repair our own hose only — and that's the problem.

Many users of other manufacturers' hose send their hose in for repair and, candidly, it's impossible to do anything with them as our procedure of repair pertains only to GOODALL hose.

We know it's disappointing when you cannot get your hose repaired. A high pressure hose is now a *capital* investment and discarding it is sheer waste. So, we suggest that, before sending in your damaged hose for repair, make sure it's a GOODALL Long-Life Rotary Hose.

Sincerely yours,

Barney

H. Barnard, *President*
GOODALL RUBBER CO. OF TEXAS

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Available through all qualified supply stores.

Favorable factors promise better markets

Surpluses are being reduced by holding crude oil production and imports within market demand

THE INDUSTRY currently is in good condition economically. Demand for petroleum continues around 4 to 5 percent above last year and at new record levels. Supplies of crude oil and products have been held within reasonable limits in July, August, and September. Inventories of crude and products are within proportions justified by prevailing market requirements.

These favorable basic conditions give good grounds for hope that industry markets and prices may gain some strength and possibly improve in coming months.

Such improvement would be the reward for the strict and painful curbing of crude production and imports in the past few months.

Markets. So far, however, the markets have remained weak and unsteady, and there is much room for improvement. Prices of products declined last spring and early summer under the weight of burdensome inventories and overproduction. They dropped back around the lowest levels of the 1958 recession, and so far have not registered much recovery.

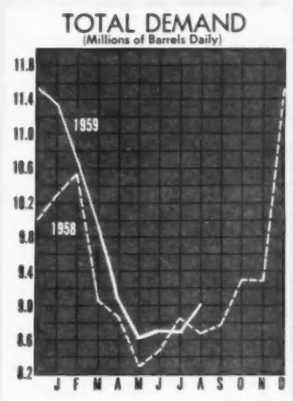
Gasoline prices were advanced moderately in July and held the gains into August but have shown some unsteadiness in September.

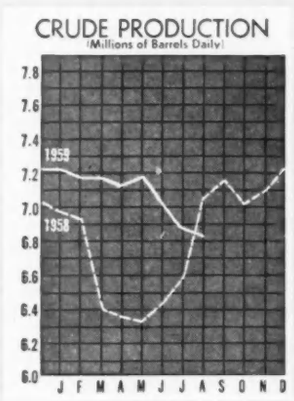
Distillate fuel oil prices traditionally are marked down in the summer to attract buyers and encourage early storing of winter supplies. But during this past summer the discounts were deeper than usual, and the prices were the lowest for several years.

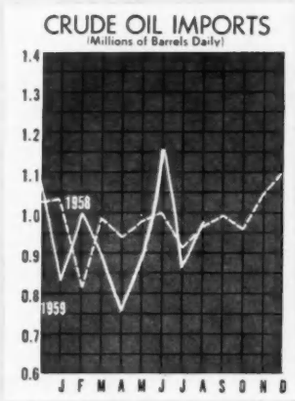
The market for residual fuel oil has been hurt by the steel strike and related interruptions of activity in other industries. Demand for residual was under last year for July and August, after having run well ahead of 1958 in earlier months this year.

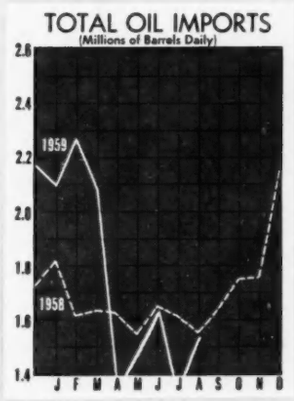
Crude oil markets were generally steady at mid-September, following regional price cuts averaging around 15 cents a barrel in California and the Four Corners area of Utah. The California reductions were blamed on oil imports from Canada and competition from natural gas.

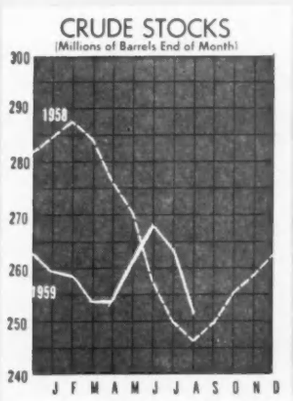
Petroleum Trends...

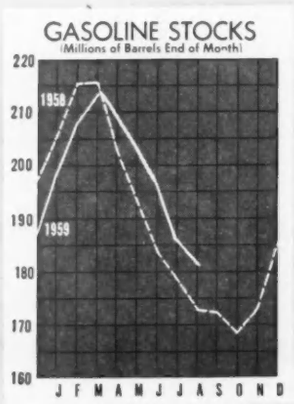


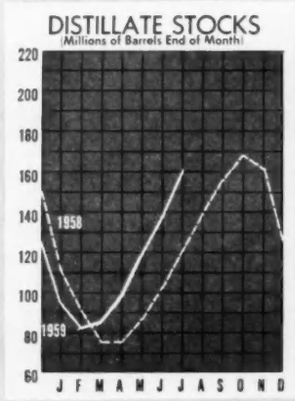


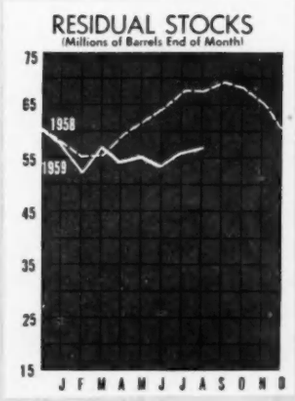


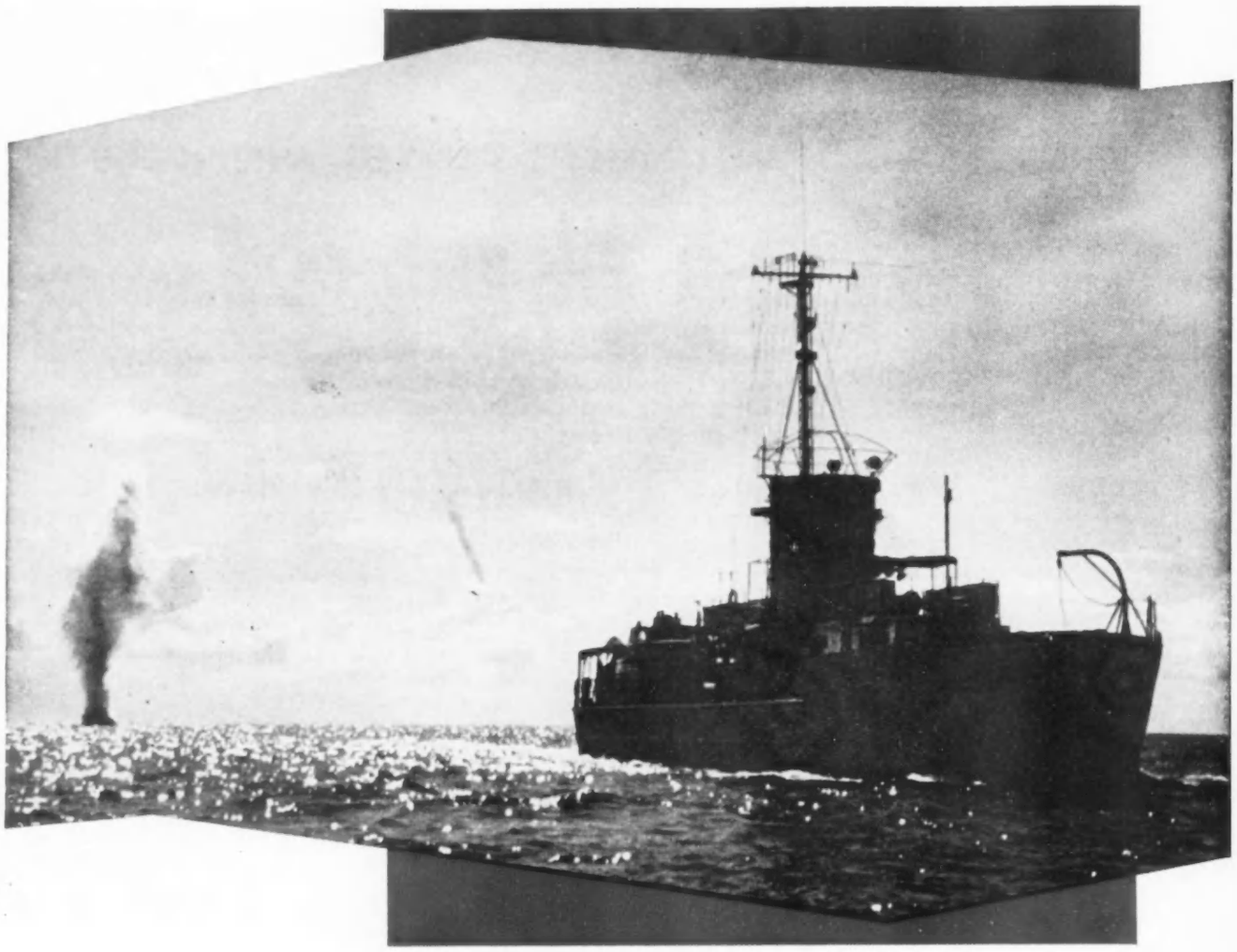












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U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	August 1959	August 1958	August % Diff.	July 1959	January-August 1959	January-August 1958	January-August % Diff.
DEMAND							
All Oils, Total Demand	9,078	8,696	+ 4.4	8,703	9,632	9,133	+ 5.5
Domestic Demand	8,823	8,392	+ 5.1	8,453	9,333	8,857	+ 5.4
Export Demand	255	304	—19.2	250	252	276	— 8.7
Gasoline, Total Demand	4,333	4,273	+ 1.4	4,436	4,122	3,948	+ 4.4
Distillate, Total Demand	1,125	1,091	+ 3.1	1,098	1,785	1,753	+ 1.8
Kerosine, Total Demand	215	172	+25.0	191	285	292	— 2.4
Residual, Total Demand	1,265	1,332	— 5.0	1,221	1,627	1,477	+10.2
Other Oils, Total Demand	2,140	1,828	+17.1	1,757	1,813	1,663	+ 9.0
CHANGE IN STOCKS							
All Oil, Change in Stocks	+145	+599	.....	+319	+170	—187	.....
NEW SUPPLY							
Total New Supply	9,223	9,295	— 0.8	9,022	9,756	8,946	+ 9.1
Domestic Production, Total	7,685	7,731	— 0.6	7,701	7,971	7,318	+ 8.9
Crude Oil	6,810	6,939	— 1.9	6,836	7,099	6,538	+ 8.6
Natural Gas Liquids	875	792	+10.5	865	872	780	+11.8
Imports, Total	1,538	1,563	— 1.6	1,321	1,784	1,628	+ 9.6
Refined Products	561	600	— 6.5	460	835	694	+20.3
Crude Oil, Total	977	963	+ 1.5	861	949	934	+ 1.6
Crude, East Coast	680	771	—11.8	624	731	762	— 4.1
CRUDE RUNS							
Crude Runs to Stills	8,106	7,824	+ 3.6	7,935	8,044	7,508	+ 7.1
Domestic Crude	7,118	6,814	+ 4.5	6,909	7,095	6,580	+ 7.8
Foreign Crude	988	1,010	— 2.2	1,026	949	928	+ 2.3

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. August 1959	TOTAL IN U.S. August 1958	TOTAL IN U.S. % Diff.	TOTAL IN U.S. July 1959	EAST OF CALIFORNIA August 1959	EAST OF CALIFORNIA August 1958	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA July 1959
All Oils	824.4	794.5	+ 3.8	819.9	.....	.....	.....	.....
Crude Oil	252.9	244.8	+ 3.3	263.7	217.7	202.9	+ 7.3	227.7
Gasoline	182.1	177.4	+ 2.6	186.2	155.5	153.8	+ 1.1	159.3
Distillate Fuel Oil	161.6	139.9	+15.5	139.8	146.5	125.1	+17.1	125.4
Kerosine	31.2	28.7	+ 8.7	29.3	30.8	28.3	+ 8.8	28.9
Residual Fuel	57.0	67.2	—15.2	55.8	30.4	34.3	—11.4	29.0
Other Oils	139.6	126.5	+ 2.3	145.1	.....	.....	.....	.....

U.S. Crude Oil Production, by States (Thous. Bbls.)

STATES or DISTRICT	Daily Average for Month Aug. 1959	Aug. 1958	% Diff.	July 1959	Total, January-August 1959	1958	% Diff.
Alabama	16.3	15.0	+ 8.7	16.2	3,403	3,895	— 12.6
Arkansas	46.7	77.3	— 39.6	81.2	18,230	19,185	— 5.0
California	844.9	850.0	— 0.6	851.4	205,327	210,437	— 2.4
Colorado	127.0	130.2	— 2.5	124.3	30,627	32,617	— 6.1
Florida	1.2	1.2	.....	1.1	284	301	— 5.6
Illinois	210.6	225.5	— 6.6	217.0	52,171	54,551	— 4.4
Indiana	32.1	29.7	+ 8.1	31.5	8,017	7,777	+ 3.1
Kansas	308.0	333.4	— 7.6	309.6	79,365	77,541	+ 2.4
Kentucky	90.8	45.6	+ 99.1	88.7	19,054	10,708	+ 77.9
Louisiana	1,035.5	851.4	+ 21.6	977.8	233,675	200,999	+ 16.3
North Louisiana	114.2	114.2	.....	115.3	29,127	27,955	+ 4.2
South Louisiana	921.3	737.2	+ 24.8	862.5	204,548	173,044	+ 18.2
Michigan	27.8	24.3	+ 14.4	27.1	6,515	6,149	+ 5.9
Mississippi	137.7	110.5	+ 24.6	131.8	30,768	24,418	+ 26.0
Mo.-So. Dak.-Tenn.	0.5	0.4	+ 25.0	0.4	46	86	— 46.5
Montana	81.8	75.4	+ 8.5	81.4	19,828	18,669	+ 6.2
Nebraska	64.6	60.6	+ 6.6	62.7	15,039	13,289	+ 13.2
Nevada-Wash.-Alaska-Ariz.	0.5	0.1	+400.0	0.5	121	27	+348.1
New Mexico	286.4	284.5	+ 0.7	293.1	69,909	64,735	+ 8.0
Southeast New Mexico	250.0	256.7	— 2.6	258.3	60,789	60,033	+ 1.3
Northwest New Mexico	36.4	27.8	+ 30.9	34.8	9,120	4,702	+ 94.0
New York	5.4	2.9	+ 86.2	5.3	1,309	1,314	— 0.4
North Dakota	40.9	45.8	— 10.7	38.7	11,355	10,108	+ 12.3
Ohio	13.6	16.6	— 18.1	13.9	3,650	4,202	— 13.1
Oklahoma	506.8	569.5	— 11.0	517.2	132,465	134,375	— 1.4
Pennsylvania	15.4	17.1	— 9.9	15.4	3,936	4,559	— 13.7
Texas	2,454.3	2,731.3	— 10.2	2,480.8	668,681	599,572	+ 11.5
Dist. 1: South Central	44.7	45.7	— 2.2	44.8	11,084	11,090	— 0.1
Dist. 2: Middle Gulf	106.5	124.9	— 14.7	105.8	29,244	26,758	+ 9.3
Dist. 3: Upper Gulf	349.6	378.3	— 7.6	356.2	95,103	89,519	+ 6.2
Dist. 4: Lower Gulf	175.9	201.4	— 12.7	175.4	47,421	44,244	+ 7.2
Dist. 5: East Central	28.2	32.5	— 13.2	28.2	7,440	7,087	+ 5.0
Dist. 6: Northeast	237.2	277.8	— 14.6	236.1	65,749	59,879	+ 9.8
Dist. 7-B: North Central	130.2	142.9	— 8.9	128.3	33,612	32,383	+ 3.8
Dist. 7-C West Central	115.9	136.2	— 14.9	116.4	31,891	31,143	+ 2.4
Dist. 8: West	950.6	1,051.7	— 9.6	976.1	262,519	217,764	+ 20.6
Dist. 9: North	205.9	206.0	— 0.1	206.6	50,531	47,344	+ 6.7
Dist. 10: Panhandle	109.6	106.0	+ 3.4	106.8	26,117	25,841	+ 1.1
Utah	109.6	101.8	+ 7.7	114.1	26,923	13,025	+106.7
Virginia	.....	.....	.....	.....	3	4	— 25.0
West Virginia	6.0	5.5	+ 9.1	5.7	1,428	1,445	— 1.2
Wyoming	345.2	333.6	+ 3.5	348.5	82,954	74,845	+ 10.8
Total, U.S.	6,809.6	6,939.2	— 1.9	6,835.4	1,725,083	1,588,833	+ 8.6

Sources for above 3 tables: Bureau of Mines monthly reports, except last 2 months based on API and B. of M. weekly reports and WORLD OIL estimates, and all Texas district data from API.

Demand. Total demand for all oils in August 1959 was 4.4 percent greater than in August 1958, with domestic consumption up 5.1 percent and exports down 19.2 percent. August brought a continuance of previous trends. For the first eight months of 1959 total demand was up 5.5 percent, with domestic use up 5.4 percent and exports down 8.7 percent. The increases of around 4 or 5 percent in total and domestic demand represent normal, traditional growth.

Gasoline demand has shown an increase of 4.4 percent for this whole year but was up only 1.4 percent in August, as sales were good in that month last year. Distillate fuel oil demand registered an increase of 3.1 percent in August 1959 and showed a gain of 1.8 percent for this year's first eight months. Kerosine demand was up sharply in August but for the first eight months was off 2.4 percent. Residual fuel oil demand was down 5 percent from last year in August, although it showed a gain of 10.2 percent for the first eight months.

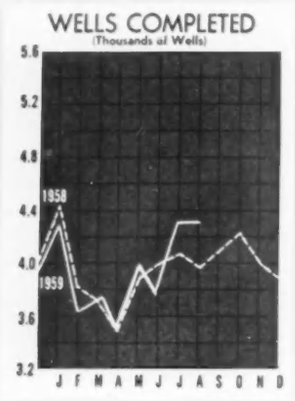
Supply. Again in August, as in July, supplies of oils were held within economically desirable bounds, and inventories were put in better shape, following the accumulation of surpluses prior to the middle of the year.

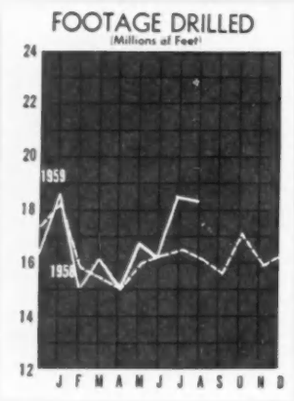
Total new supply in August 1959 was held about 1 percent under August 1958, with total imports down 1.6 percent and domestic crude production off 1.9 percent.

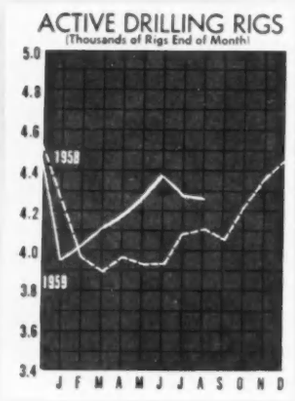
Runs to Stills. Refinery runs were not held down as effectively in August as crude production and imports. In averaging 8,106,000 barrels daily they were up somewhat from July and 3.6 percent above August 1958. Processing crude in this volume required large withdrawals from storage. Crude stocks were cut to 252.9 million barrels at the end of August from 263.7 million at end of July, a drop of 10.8 million barrels or 348,000 daily.

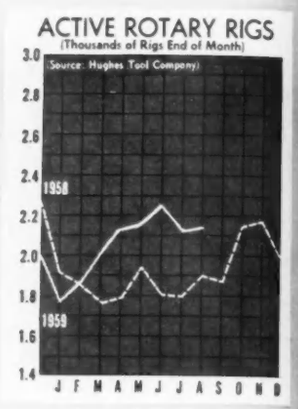
Stocks. Refinery output of products was not so great, however, as to put product inventories into bad shape. Gasoline stocks were seasonally reduced from 186.2 million to 182.1 million barrels during August.

Drilling Activities...









Drilling activity up in first 8 months

U.S. Drilling rig totals, new well completions and footage drilled were down slightly on August 31 from the end of July. However, the totals continued to show a significant improvement over those reported on the same date in 1958.

Active rigs totaled 4,234 at August's end, 1.3 percent under the 4,290 rigs reported on July 31, and 73 rigs or 1.7 percent more than the 4,201 rigs operating on Aug. 31, 1958.

New well completions averaged 139 wells per day during August, down 2 wells per day or 1.4 percent from the July average of 141 wells completed daily, and up 4.5 percent over the 133 wells per day average during August 1958.

Footage drilled averaged 590,323 feet per day in August, down 2.1 percent from the July average of 603,236 feet. However, footage drilled during the first eight months of 1959 totaled 129.7 million feet, up 4 percent over the same 1958 period.

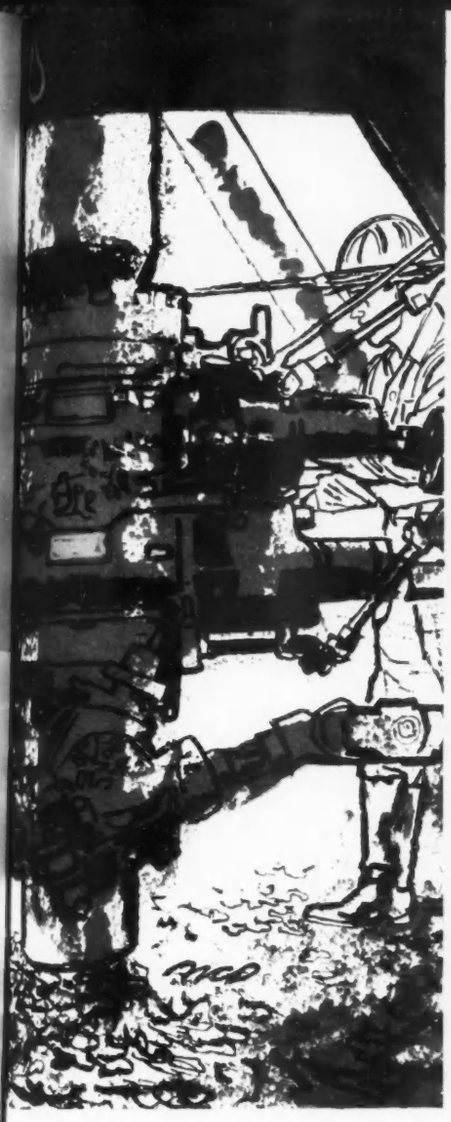
Operators drilled 6,416 wildcats during the first eight months of 1959, 0.8 percent more than were completed during the same period in 1958.

Summary of U.S. Drilling Activity

ITEM	August 1959	July 1959	EIGHT MONTHS January-August 1959	1958	% Diff.
New Wells Completed:					
Oil	2,119	2,180	16,387	15,884	+ 3.4
Distillate	66	63	542	509	+ 6.5
Gas	337	387	2,623	2,823	— 7.1
Service	74	58	521	798	— 34.7
Dry	1,717	1,682	12,101	11,874	+ 1.9
Total New Wells	**4,313**	**4,370**	**32,174**	**31,888**	**+ 0.9**
Footage Drilled (Million Feet)	**18.3**	**18.7**	**134.9**	**129.7**	**+ 4.0**

Summary of U.S. Wildcat Drilling

ITEM	August 1959	July 1959	EIGHT MONTHS January-August 1959	1958	% Diff.
New Field Discoveries:					
Oil	74	63	478	487	— 1.9
Distillate	8	6	64	64	.....
Gas	14	19	159	153	+ 3.9
Total Discoveries	**96**	**88**	**701**	**704**	**— 0.4**
Dry Wildcats	**862**	**826**	**5,715**	**5,662**	**+ 0.9**
Total Wildcats	**958**	**914**	**6,416**	**6,366**	**+ 0.8**
Percent Productive	10.0	9.6	10.9	11.1	.....
Percent Dry	90.0	90.4	89.1	88.9	.....



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U. S. Drilling Activity in August and First Eight Months, 1959-1958

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR AUGUST, 1959 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Aug. 1959	July 1959	Aug. 1958	Total Footage August 1959	DETAILS FOR JANUARY-AUGUST — NEW WELLS — 1959	1958	Percent Diff.	FOOTAGE — 1959	1958	WILDCAT DRILLING IN AUGUST AND FIRST EIGHT MONTHS, 1959-1958: DETAILS FOR AUGUST, 1959 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-AUGUST — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1959	1958	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down) — Aug. 31 1959	July 31 1959	Aug. 31 1958
Alabama	5	....	....	3	....	8	7	6	67,752	74	51	+ 45.1	658,917	431,122	....	....	....	3	3	....	....	....	23	23	19	8	13	13
Alaska	....	....	....	....	....	....	1	....	....	5	....	....	61,887	....	....	....	....	....	....	1	....	....	3	4	....	7	6	....
Arkansas	34	....	5	25	....	64	74	101	232,803	528	496	+ 6.5	1,764,252	1,658,296	1	....	2	7	10	3	....	6	70	79	103	49	37	49
California	75	....	9	42	6	132	103	104	698,397	950	989	— 4.0	4,561,403	4,664,258	2	....	....	30	32	3	....	5	183	191	193	135	145	134
Colorado	13	....	3	53	....	69	88	77	386,847	493	555	— 11.2	2,591,602	2,882,548	2	....	1	35	38	15	....	7	250	272	300	60	64	65
Florida	....	....	....	1	....	1	1	1	15,475	5	5	.....	44,501	48,804	....	....	....	1	1	....	....	....	5	5	5	1	2	2
Georgia	....	....	....	....	....	....	....	....	....	1	....	....	990	....	....	....	....	....	....	....	....	....	1	1	....	....	....	1
Illinois	102	....	2	117	....	221	176	217	475,275	1,358	1,450	— 6.4	3,017,381	3,315,459	1	....	....	50	51	8	....	....	304	312	382	289	299	301
Indiana	25	....	1	63	....	89	96	73	142,247	585	492	+ 18.9	948,780	806,740	....	....	....	30	30	....	....	1	161	162	133	94	94	109
Kansas	163	....	12	182	3	360	347	320	1,289,102	2,494	2,324	+ 7.3	9,161,896	7,997,912	17	....	....	90	107	98	....	15	639	752	613	284	302	365
Kentucky	137	....	21	96	1	255	263	239	232,121	‡1,909	1,427	+ 33.8	‡1,739,843	1,386,635	1	....	....	8	9	8	....	....	55	63	48	198	195	118
Louisiana	168	22	35	142	....	367	360	331	2,732,548	2,486	2,288	+ 8.7	19,393,137	18,369,013	....	2	3	48	53	20	12	8	309	349	378	356	374	339
North Louisiana	77	....	19	69	....	165	146	145	571,717	946	820	+ 15.4	3,366,219	3,109,013	....	....	1	25	26	11	1	1	109	122	116	70	72	72
South Louisiana	91	22	16	73	....	202	214	186	2,160,831	1,540	1,468	+ 4.9	16,026,918	15,260,000	....	2	2	23	27	9	11	7	209	227	262	286	302	267
*Gulf of Mexico	19	2	5	14	....	40	41	55	442,836	312	355	— 12.1	3,213,748	3,404,922	....	....	1	2	3	1	2	3	17	23	31	50	60	35
Michigan	28	....	1	27	....	56	50	28	185,657	366	249	+ 47.0	1,102,630	726,138	....	....	1	18	19	2	....	1	88	91	85	97	98	78
Mississippi	26	1	....	24	....	51	59	35	465,422	420	247	+ 70.0	3,892,952	2,213,516	1	....	....	13	14	7	....	2	148	157	101	88	74	50
Missouri	....	....	....	....	....	....	3	1	.....	9	11	— 18.2	9,039	9,872	....	....	....	....	....	1	....	....	6	7	4	....	....	2
Montana	7	....	....	12	....	19	47	24	92,407	206	203	+ 1.5	988,151	1,086,893	1	....	....	8	9	2	....	....	58	60	84	50	45	40
Nebraska	20	....	....	54	....	74	114	51	439,749	554	420	+ 31.9	3,298,784	2,495,337	1	....	....	34	35	27	....	....	219	246	194	41	40	44
New Mexico	100	....	30	36	....	166	174	210	759,331	1,138	1,345	— 15.4	4,719,949	6,353,121	4	....	1	21	26	29	1	13	130	173	187	159	154	169
Southeast New Mexico	66	....	4	23	....	93	69	105	486,010	611	688	— 11.2	2,968,483	3,425,347	3	....	4	16	20	21	....	4	93	118	113	76	80	61
Northwest New Mexico	34	....	26	13	....	73	105	105	273,321	527	657	— 19.8	1,751,466	2,927,774	1	....	....	5	6	8	1	9	37	55	74	83	74	108
New York	10	....	....	2	7	19	19	22	29,400	150	154	— 2.6	238,580	244,587	....	....	....	....	....	....	....	....	....	....	....	25	25	42
North Dakota	19	....	....	11	....	30	49	40	187,550	309	286	+ 8.0	1,923,114	1,891,134	1	....	....	6	7	12	....	....	45	57	89	33	39	31
Ohio	36	....	25	22	....	83	95	92	214,315	628	660	— 4.9	1,703,257	1,702,337	....	....	....	4	4	5	....	2	12	19	7	218	216	227
Oklahoma	244	5	25	145	29	448	459	529	1,804,669	3,922	4,746	— 17.4	14,195,263	14,851,171	9	....	....	53	62	47	10	21	432	510	501	478	503	445
Pennsylvania	12	....	24	4	6	46	51	74	144,174	380	501	— 24.2	1,274,391	1,496,813	....	....	....	1	1	....	....	2	8	10	19	138	153	222
South Dakota	1	....	....	....	....	1	2	2	8,636	10	5	+ 50.0	56,892	22,187	....	....	....	....	....	2	....	....	4	6	5	8	....	4
Tennessee	....	....	....	3	....	3	5	4	3,975	38	20	+ 90.0	45,975	25,100	....	....	....	3	3	....	....	....	17	17	6	....	....	....
Texas	836	38	81	592	21	1,568	1,529	1,360	6,998,111	11,888	11,642	+ 2.1	52,305,601	49,605,844	29	6	5	364	404	174	40	66	2,315	2,595	2,696	1,032	1,040	980
Dist. 1: South Central	20	....	2	39	....	61	88	61	164,101	646	641	+ 0.8	1,655,863	1,562,872	1	....	....	32	33	6	....	1	212	219	236	37	49	34
Dist. 2: Middle Gulf	21	9	5	34	....	69	67	62	496,422	534	480	+ 11.3	3,300,601	2,900,794	1	3	1	25	30	8	12	9	167	196	155	38	57	34
Dist. 3: Upper Gulf	44	14	5	52	....	115	112	106	788,399	814	867	— 6.1	5,828,613	5,540,734	4	2	1	29	36	9	19	7	154	189	238	94	95	67
*Gulf of Mexico	....	....	....	....	....	....	....	1	.....	1	9	— 88.9	11,005	72,271	....	....	....	....	....	....	....	1	....	1	7	2	2	....
Dist. 4: Lower Gulf-S.W.	39	15	14	46	2	116	117	96	625,501	898	814	+ 10.3	4,839,848	4,184,145	2	1	2	30	35	11	8	8	253	280	324	92	95	54
*Gulf of Mexico	....	....	....	....	....	....	....	....	.....	.....	7	—100.0	.....	75,300	....	....	....	....	....	....	....	....	....	....	2	1	....	....
Dist. 5: East Central	....	....	3	8	....	11	11	12	81,207	84	126	— 33.3	473,838	473,217	....	....	....	5	5	1	....	1	41	43	75	13	9	14
Dist. 6: Northeast	56	....	5	24	1	86	79	63	432,863	564	558	+ 1.1	3,081,045	2,943,772	1	....	....	16	17	7	....	5	103	115	143	61	52	65
Dist. 7-B: North Central	89	....	4	127	2	222	162	183	686,287	1,606	1,438	+ 11.7	5,118,312	4,631,607	7	....	....	73	80	46	....	9	478	533	506	101	100	79
Dist. 7-C: West Central	41	....	....	31	1	73	81	57	305,415	507	534	— 5.1	2,111,576	2,649,525	2	....	....	23	25	16	....	9	138	163	155	65	65	71
Dist. 8: West	283	....	6	83	3	375	346	318	2,086,168	3,063	2,817	+ 8.7	15,547,096	13,590,232	5	....	1	56	62	41	....	4	329	374	342	278	294	290
Dist 9: North	159	....	12	130	12	313	348	299	825,607	2,375	2,506	— 5.2	6,680,894	7,275,773	4	....	....	66	70	19	....	2	365	386	433	150	136	169
Dist. 10: Panhandle	84	....	25	18	....	127	118	103	506,141	797	861	— 7.4	3,667,915	3,853,173	2	....	....	9	11	10	1	11	75	97	89	103	88	103
Utah	4	....	....	3	....	7	19	22	36,293	187	294	— 36.4	1,038,175	1,628,043	2	....	....	....	2	4	....	2	39	45	58	48	43	35
Washington	....	....	....	1	....	1	....	....	5,990	1	4	— 75.0	5,990	20,794	....	....	....	1	1	....	....	....	1	1	3	2	....	....
West Virginia	13	....	59	10	....	82	71	71	197,453	516	557	— 7.4	1,312,985	1,495,540	....	....	....	....	....	....	....	....	....	....	5	246	213	213
Wyoming	40	....	4	45	1	90	101	72	465,452	546	451	+ 21.1	2,840,005	2,205,705	2	....	1	32	35	10	1	8	176	195	132	111	98	114
Others	1	....	....	2	....	3	7	3	10,980	18	16	+ 12.5	52,270	73,631	....	....	....	2	2	....	....	....	14	14	16	19	18	9
Total United States	2,119	66	337	1,717	74	4,313	4,370	4,109	18,322,131	32,174	31,888	+ 0.9	134,948,592	129,708,550	74	8	14	862	958	478	64	159	5,715	6,416	6,366	4,274	4,290	4,201
Total Western Canada	125	....	35	60	....	220	227	237	1,045,000	1,681	1,706	— 1.5	8,199,287	8,481,800	....	....	....	....	....	....	....	....	....	....	....	166	204	238

* Gulf of Mexico wells are included in their respective district totals. ‡ Kentucky for first 6 months of 1959 has been revised to 1,391 wells and 1,276,417 feet from originally reported 731 wells and 1,040,917 feet.

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As an example, in many instances drill collars are lodged some distance from the bottom of the hole and when washed over they fall to the bottom, necessitating an extra trip into the hole to retrieve them. And, in many cases the collars lodge on the bottom requiring additional washover operations.

The Homco Drill Collar Spear is designed to prevent this. This tool has the spear attached to the wash pipe through shear pins allowing the spear to be screwed into the joint connection of the collar. After the connection is made the pins are easily sheared, allowing washover to begin. The spear is in the catch position as the collars are washed over preventing the collars from falling. A free point indicator may be operated through this tool at any time.

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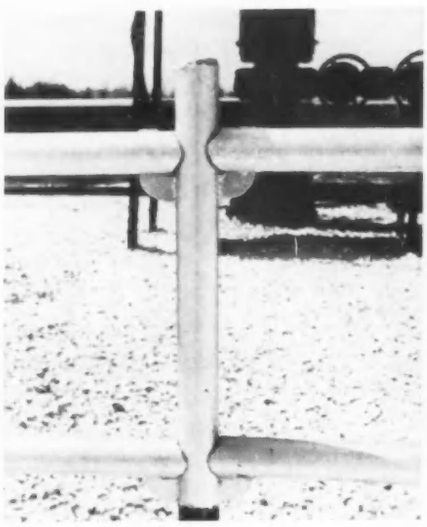


FIGURE 1

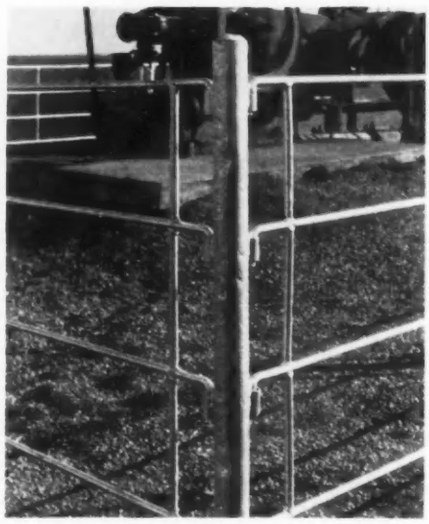


FIGURE 2

Make Removable Fence From Scrap Pipe

Here are three different types of lease fences used to protect wells and producing equipment. All three types can be constructed from scrap materials found on the lease. A minimum of welding time also is required for a sturdy installation.

Figure 1 shows a removable well fence constructed entirely of junk 2-inch line pipe. As shown, the vertical member is provided with four L-shaped pieces of steel at the top and bottom. The horizontal members are provided with matching slots for the L-shaped pieces of steel on the post. The fence post is set in concrete. To remove the fence, the horizontal sections are simply lifted upwards and disengaged from the L-shaped pins welded to the post. The entire fence can be removed in a matter of minutes.

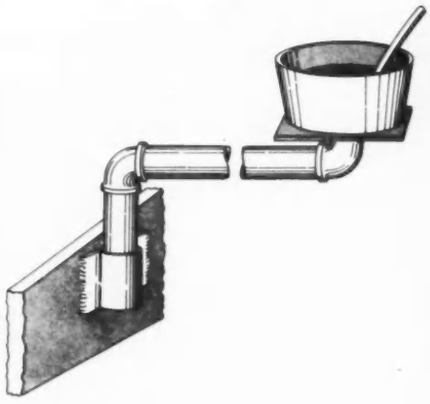
A quantity of junk sucker rods has been used to construct the well fence illustrated in Figure 2. Three vertical lengths of sucker rod are welded next to each end of the horizontal fence section to provide rigidity. The ends of the sucker rods are bent at a 90-degree angle to engage pipe collars which have been welded onto the 2-inch pipe used as corner posts. Size of these collars depends upon the size of sucker rods used for the fence sections. An upward movement again completely disengages the horizontal fence sections and facilitates immediate removal.

FIGURE 3

A third type of removable lease fence is shown in Figure 3. This method uses junk 2-inch pipe and a short section of steel sucker rod as its main components. The sucker rod is welded to the end of the horizontal fence member at a 90-degree angle. A piece of small pipe of the correct diameter to receive the sucker rod is then welded lengthwise to the vertical fence post. Again, the entire fence can be removed in a matter of minutes by lifting upwards and disengaging the sucker rod portion of the horizontal members from the small pipe receivers.

Prevent Serious Injuries With Metal Hand Plate

The steam escaping from a valve can cause serious burns to the roughneck who operates it. To avoid such an injury, a solid metal round plate can be fitted with a handle and then fixed to the steam valve control rod. Now the valve can be controlled without danger of burned hands.



Make a Pushaway Holder For Tool Joint Lubricant

Two pieces of pipe, a couple of elbows and a bracket can be made into a pushaway holder that will keep a can of tool joint lubricant handy when in use and off the rig floor at other times.

Weld a metal bracket to the chain guard so that a piece of 2-inch pipe can be inserted and held smugly. Complete the holder with another piece of pipe and two elbows. Size the pipe so that it will be the right height above the rig floor and the right length to be convenient for the crewmen when running pipe.

The stand can be swung past the chain guard and out of the way when the floor is being cleaned or work other than running-in pipe is underway on the rig floor.

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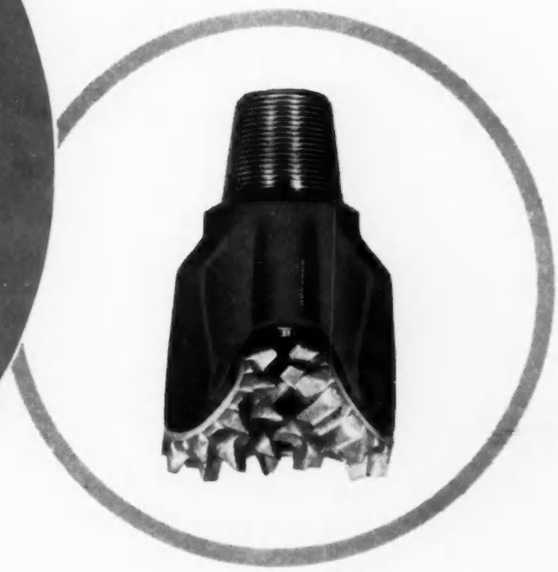

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Make Piston Ring Compressor from Scrap

Here's a field expedient which one operator used after breaking his piston ring compressor for large bore engines. A piece of strap steel approximately 1/32-inch thick and 3 inches wide was obtained and shaped around the piston. The ends of the strap (after shaping) were bent back approximately 1 inch short of where the ends would normally meet.

When using the device to compress piston rings, the strap is slipped over the piston as indicated and a pair of vise grips are used to pull the ends together. This compresses the ring sufficiently so that the piston can be re-inserted in the cylinder.

Protect Pump Rods With Unitized Lubricator

This lubricator is in a combination protective case and oil reservoir by forming a partition box of ¼-inch steel plate. This partition is placed in the center of the steel box and runs from one end to the other. Oil is placed on one side of the partition and a ½-inch rotary pump is bolted inside the other half. Inlet and outlet pump connections are piped through the metal case to the rod section of the mud pump.

A glass gage is mounted on the reservoir side of the case to indicate the fluid level at all times. The pump pulley extends out the back side of the case and a belt drive runs from the bull shaft of the mud pump to the pulley on the small lube pump. The method insures adequate lubrication at all times of the pump rods while the small rotary pump is protected from damage by falling tools or equipment.

Motor Under Samson Post Saves Needed Space

To economize on the pumping unit base and also on the concrete foundation, one operator places his electric motor under the samson post. The motor mounted on slotted rails can be adjusted the same as when mounted at the pitman end of the unit.

However, when placed under the samson post it forms a small unit, taking up less space at location, requiring fewer guard rails and is far less likely to be damaged during workover or pulling operations.

Keep Pump Rods Handy With Holder Made of Pipe

Pump rods should be properly stored and whenever possible, should be located whereby they are easily accessible to the pump. The operator of a West Texas rig has rigged up a handy holder for the pump rods on the back of the skid-mounted work bench.

The rod holder consists merely of a pipe slightly larger in diameter than the rod itself. A cover is welded at one end of the holder and the rod is welded to the side of the work bench. The rods may be placed into the slanted pipe and are easily stored until they are needed.

Build Lubricator Reserve Tank from Sheet Iron

For added lubricating oil reserve on a compressor unit, an additional oil reservoir can be built from 1/16-inch sheet iron. The additional tank can be made to any desired size. It is mounted to the rear of the compressor lubricator and attached to the compressor lubricator tank with ⅜-inch copper tubing.

A 2-inch nipple with 2-inch pipe cap used for cover is installed on the additional reservoir for a filler cap. The additional lubricating oil reserve allows the compressor to operate for longer periods of unattended operation and does not require as close checking as normal.

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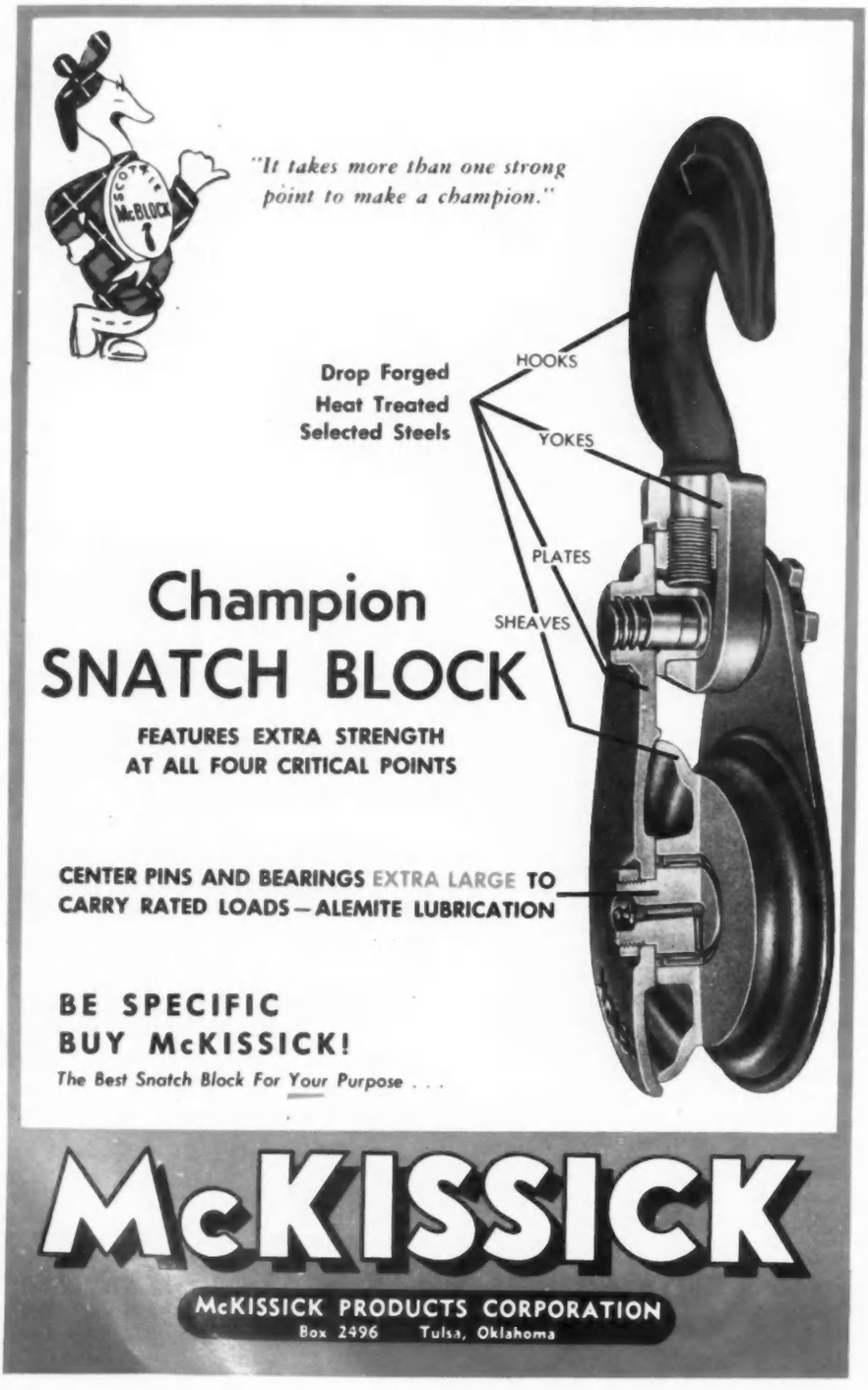
Rig-Built Collapsible Table Serves Useful Purposes

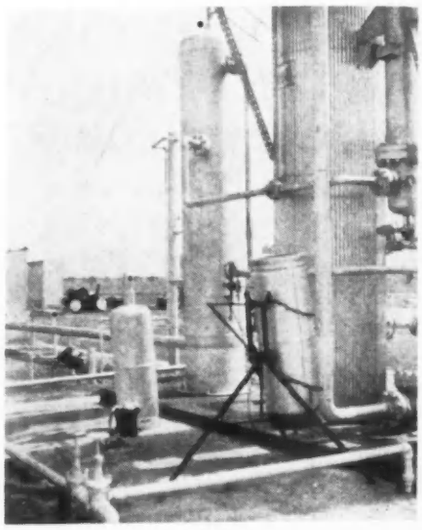
A collapsible table can have a variety of uses around a rig. It can be used to hold recording instruments, mud testing equipment, drinking water can, etc. If and when the rig is to be moved from one location to another, this table will fold up into a compact unit.

The table is made of four pieces of angle iron to form the legs. The legs are then connected at the cross with a threaded piece of rod. The rod runs through a slightly larger diameter pipe so that the legs are able to swivel.

Each pair of legs is connected at the top by a piece of angle iron to form a base for the wooden table top. This top is two pieces of lumber, 2 inches x 12 inches x 30 inches.

For stability which is necessary around the rig, the base of the legs are securely fastened to the floor by either heavy log bolts or nails.





Construct Dew Point Tester Stand from Scrap Material

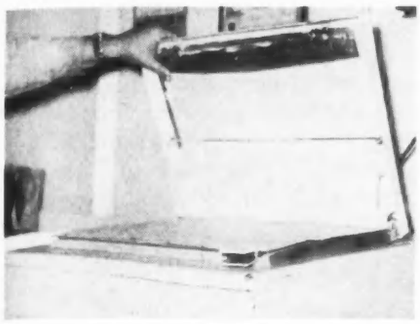
This dew point tester stand was constructed of scrap 1-inch pipe and a 10¾-inch casing thread protector. The thread protector is used as a base for the coolant gas bottle. By installing the gas bottle upside down on the thread protector, the operator is assured of utilizing all gas in the bottle.

The dew point tester is installed on the same stand as the bottle for maximum convenience. With both bottle and tester installed on the same unit the stand can be moved with ease to any desired point.

Metal Cover Keeps Daily Drilling Reports Neat

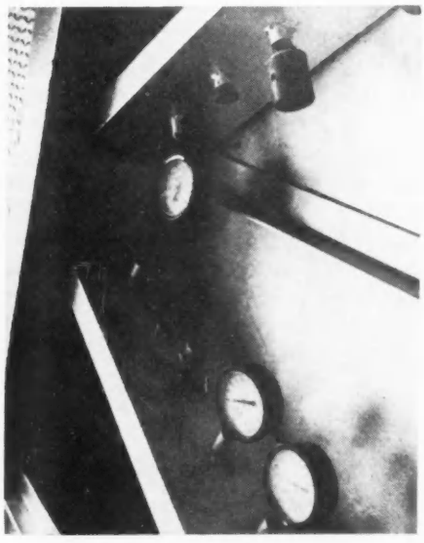
Accurate and clean drilling reports are a must for efficient drilling operation. A West Texas drilling contractor uses a cover which has certainly proven satisfactory in maintaining the above type of records.

A piece of metal, a little larger than the regular AAODC daily dril-



ling forms, is cut and formed to make a complete covering for the drilling report. This cover is then hinged to the top of the "knowledge box" in the doghouse. A wire is placed approximately halfway up on the cover so that each daily report may be folded under the wire leaving only the current day's report exposed. The top of the report (in the cover) can be clamped so that there is no tendency for the previous day's report to hang over and interfere while writing the present day's report.

This cover will not only keep the records clean but will serve as a very useful and adequate place to keep the records until the well is completed.



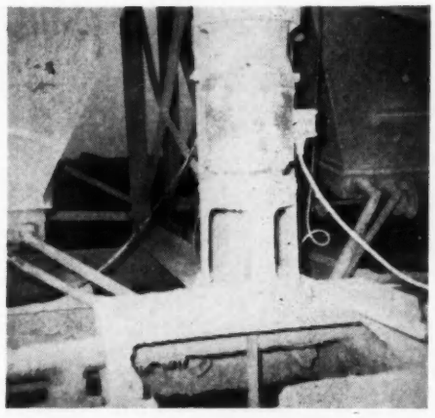
Store Pressure Gages On Tool Shed Girder

A convenient girder in the tool shed can double as a storage rack for pressure gages. Weld to the girder several different sizes of coupling or nipples with the same type of thread as the gages. Screw the gages securely into the nipples. This provides a good storage place and gages are protected from damage during moves.

Hoppers Empty Directly Into Suction Pit by Raised Tanks

Instead of discharging bulk barite into a hopper and then pumping the mud-barite mixture into the suction pit, a Gulf Coast operator has arranged to have the bulk hoppers empty directly into the suction pit.

In order to get the tank high enough, a super structure was built under the bulk tanks thus raising them up to the level of the pits. The weight material is discharged directly into the suction pit and stirred in with the pit mixer. This method avoids plugged hoppers and increases the rate of weighting up the mud.



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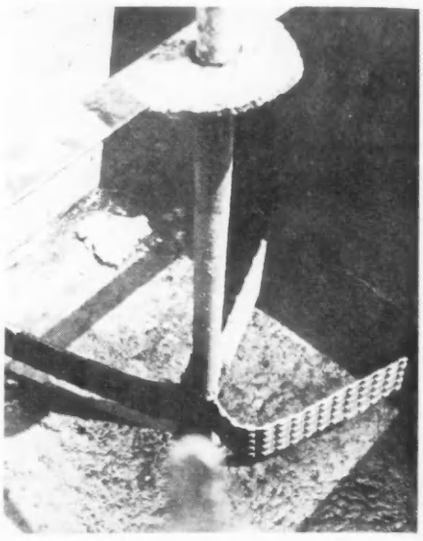
Use a Blackboard as Doghouse Message Center

A small blackboard can be very helpful when installed in the pumper's doghouse. Space is provided for gages, wells on test, wells shut-in or to be shut-in, wells to be opened up, etc. It is especially useful in this respect since relief pumper personnel are not likely to overlook important messages posted in such a prominent place.

It is also helpful to the day pumper. He can consult the board before going off tour and immediately know whether or not a tank should be switched. This operator used a piece of slate for his board. One can be made from a piece of sheet rock painted with flat black paint if slate is not available.



Build a Pipe Agitator For Mixing Mud Chemicals

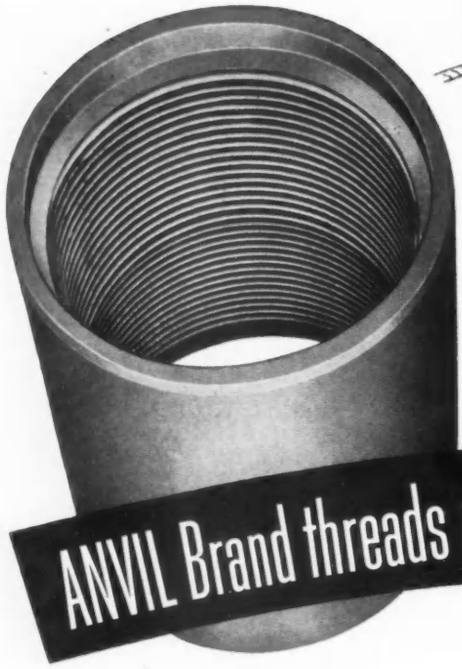
A simple pipe agitator for potentially dangerous mud and chemicals can be built with a piece of 2-inch pipe and three pieces of metal as the blades. The pipe is passed through a hole (a little larger than the pipe) in a plate to insure rigidity at the top. Place the other end of the pipe inside a nipple slightly larger than the pipe so that as the agitator is rotated the lower end will not move around at the bottom of the tank. A wheel or some other convenient arrangement can be used to transmit a rotational movement to the pipe.

Rack on Doghouse Wall Protects Rods, Pistons

Build a rack on the doghouse wall to protect extra pump rods and pistons. Such a rack also will keep the equipment in sight for inventory purposes.

The top and bottom portions of the rack can be made from metal scraps or wood. The two parts are then mounted a rod's length apart. Well dog legs of sucker rod metal to the wall and use 1 by 4-inch board as a hasp to keep the rods in place even while the doghouse is being moved.

When you're making string



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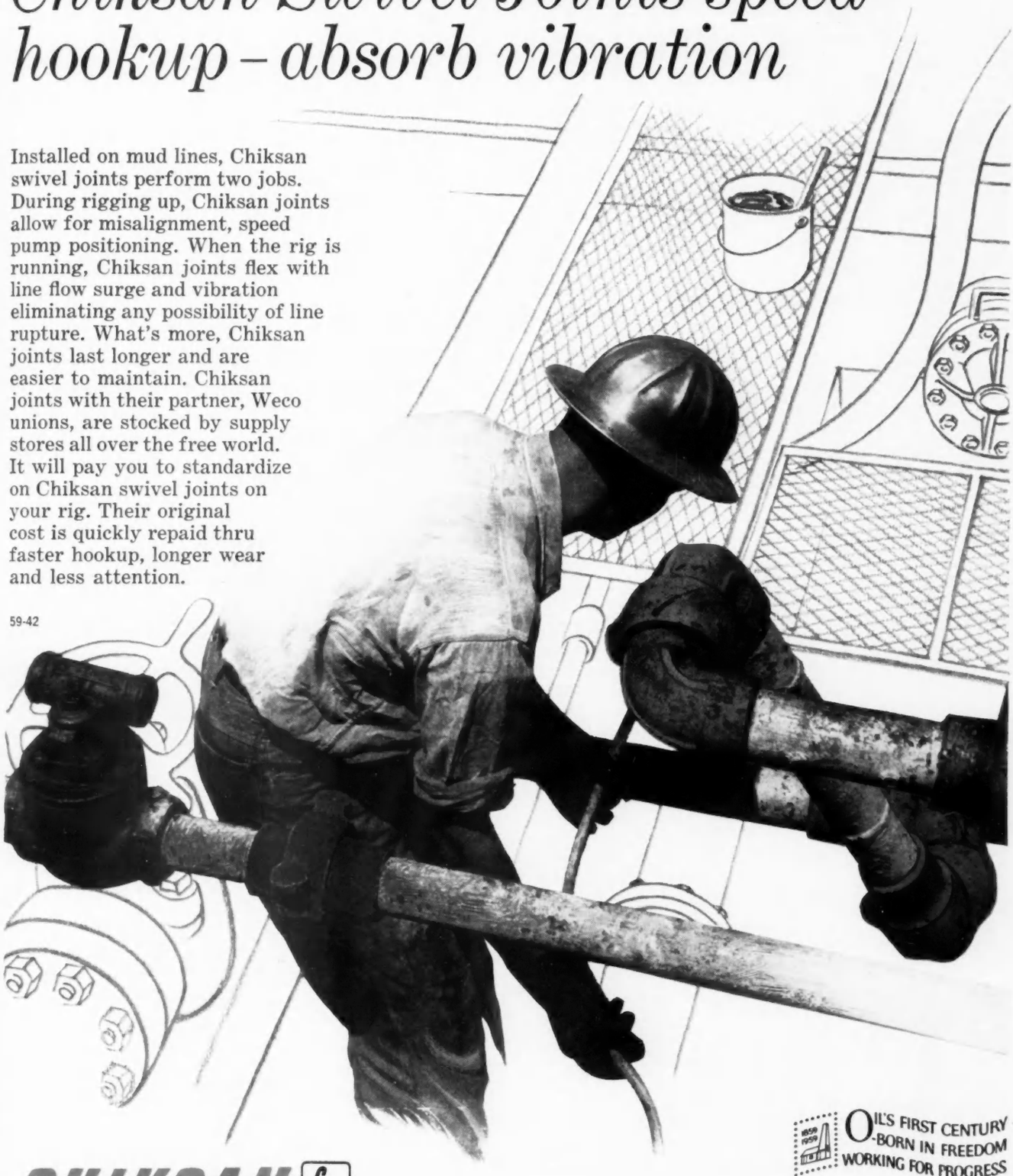

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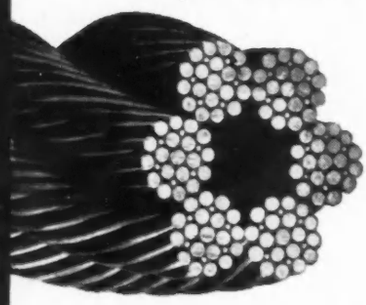

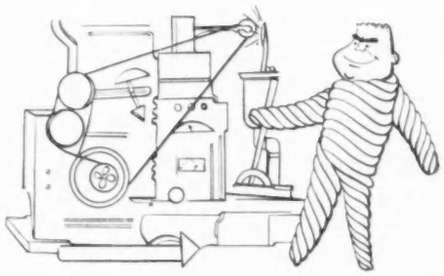

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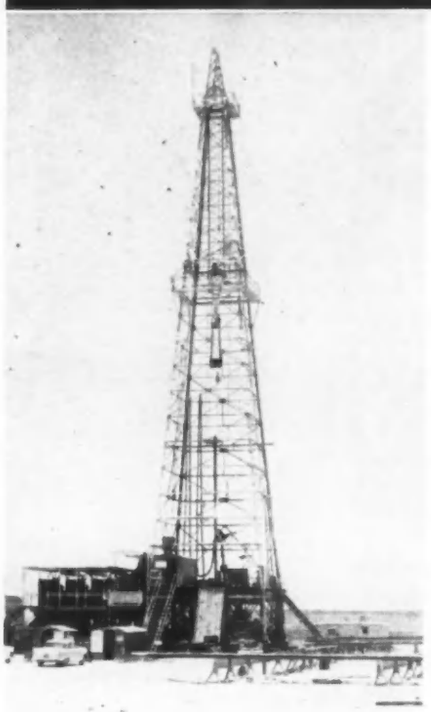

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The drilling industry is characterized by its periods of ups and downs, its obstacles and achievements, its challenges and progress. These cycles are responsible for the success which the industry has attained and for the major role it plays in the continuing search for oil.

WORLD OIL has devoted this special report to progress in this field. Technological advancements are discussed on the following pages; the industry itself is evaluated in this editorial.

The drilling contractor—in a class by himself

Joseph Zeppa

By Joseph Zeppa, President
American Association of Oilwell Drilling Contractors

H. S. M. BURNS, president of Shell Oil Company, was recently quoted as saying:

"The oil industry has served the nation well because it is a profitable industry. The word "profit" has been much maligned of late. We need to remind ourselves that reward for accomplishment is a basic precept of a free society. The strides that have been made by American businessmen in the Twentieth Century are due, principally, to the fact that there is a reward for effort in the form of profit."

World-wide, there is an oversupply of crude oil and there is an oversupply of refined products, but oil companies are managing to make a profit. There's too much wheat and too much corn and too much cotton, but the farmers are prospering. There is an overproduction of many other things, but industry, generally, is operating pofitably.

There are, also, too many drilling rigs for the available contracts, but the drilling contracting business hasn't made a profit in more than three years.

What's the answer? No use looking to Congress to prorate drilling rigs or to pay the contractors for stacking rigs. It hasn't been any more successful in balancing the country's budget than the contractor has been in balancing his.

My fellow contractors seem to think that since I was elected president of American Association of Oilwell Drilling Contractors I'm bound to have some solution to the problem which hasn't occurred to them. Well, I do not have a solution—merely a suggestion:

Bid from your cost estimates and not from your estimate of the price your competitor is likely to bid. When a contractor has made a trip to the well location, figured out the number of bits, drilling time, cost of transportation, labor, fuel, supplies, depreciation, overhead and a tiny margin for his creditors and arrived at a price of, say, $6.75 per foot and $1,050 per day, it is the poorhouse for him to bid $5.60 per foot and $850 per day to underbid his competitor. He just can't do it and stay in business.

Each of us and each only can cure the ills affecting the industry. Our customers can't do it for us, and those of us who think otherwise are not facing reality.

What's the cause of this sad plight of the contracting business? During the past 28 years, I have participated in the trials and tribulations which affect it and have enjoyed the excitement, satisfaction and rewards which this fascinating business has brought to so many of us. I think I understand it, but never cease to wonder at its vagaries. The economic difficulties of the drilling contracting business stem from and are inherent in its composition.

There are approximately 3,400 rotary rigs in the United States. These represent an investment of close to $750 million. These rigs, plus cable tool rigs, drill about 95 percent of all the wells—so, in 1958, they drilled about 46,500 wells. Assuming the contractor's bill to be $25,000 per well, in 1958 he collected from and spent for his customers about $1.2 billion.

If the contractor had made a profit of only 6 percent on his investment and depreciation of 15 percent on his equipment, he would have had about $167 million to satisfy his creditors, replace and modernize his equipment and attract better personnel into his business, and this would have amounted to only 14 percent of his gross business.

There are very close to 1,000 contractors in the United

States. The largest proportion, by far, own three rigs or less. Most of these operate in limited areas, have small organizations and personally manage their own business. A comparatively small number operate in most of the active oil producing areas and maintain large organizations, technical supervisors and engineers.

The salary and wage pattern is not uniform in the different areas or within the same area; fringe benefits (vacations, insurance, retirement) are neither uniform nor general. Labor costs, therefore, vary materially between the highs and the lows.

Other contractors, with heavy financial obligations, feel they can stay in business as long as they take in a little more cash than they pay out, but are sure to go out if they shut down.

Suppliers generally carry the contractor so long as he meets his current bills. They prefer a customer to the possession of an old rig. Unfortunately, many customers and rigs wear out in the end. That is the drilling contract business and those are some of the reasons for its economic ailments.

Consequently, banks do not consider drilling equipment good security and investors don't class the drilling business as a AAA hedge against inflation. Thus, the supplier has been, is and will be the contractor's friend and banker and even he thinks it sometimes gets mighty tedious.

If competition is the life of trade, the drilling business should be mighty lively. Someone has described the drilling contract business as the one, pure, unadulterated form of competitive free enterprise in existence and functioning in the United States. That might tickle the ego of the Anti-Trust Division of the Justice Department—and should. But what does it get the drilling contractor? Not even a kind word.

This survey showed that the cost of drilling and completing wells had increased substantially since 1955—about 8.2 percent. When the drilling contractors read that, they must have felt mighty discouraged. It seemed that despite their sacrifices and throat cutting they had contributed to the inflationary spiral which the Republicans had been dreading. Then they took out the contract file starting with 1955 and discovered that the footage prices and daywork rates had declined every year up to date in practically every field and for every depth they drilled and, in the last bid, they had cut another 10 cents per foot "to meet competition."

Perplexed, I looked over the report again. Apparently, I didn't read it right. It said "drilling and COMPLETION costs" (the emphasis is mine). So, we contractors weren't to blame, after all. It's possible, though, that the impression is already abroad in the industry that we contractors have been the main culprits.

Well, you naturally wonder, if matters are all that bad, how have the contractors been able to stay in business in the face of reduced prices for their work and increased costs of everything they buy and the labor they employ?

The answer is that not all are staying. Some have gone out, others are going and the rest are hanging on by drilling wells faster and faster, cutting expenses and not replacing their old equipment with better and more modern necessary to continued progress. They also have to forego the pleasure of increasing wages and paying fringe benefits enjoyed by other branches of the petroleum industry, even if these result in serious deterioration and reduction in qualified, trained drilling personnel.

Conditions cannot improve until available work becomes more in balance with the available equipment. One cannot reasonably expect a substantial increase in the number of wells drilled during the next two years. Consequently, the balance can only be achieved by a reduction in the number of workable rigs from obsolescence and wear and tear. Although this has been occurring for some time, rigs are mighty durable things. However, the number of contractors who have found it desirable or necessary to go out of business and who will continue doing so are accelerating natural attrition, since their older equipment is, generally, dispersed and no longer continues to function as an operating unit.

It does not seem prudent, however, to expect a substantial improvement in the contracting business generally before 1961, although, in some areas, the demand for particular types of rigs not in surplus supply will tend to stabilize prices at a reasonable level before that time.

Is the customer to blame for this situation? Yes and no.

Yes, because he takes full advantage of the competitive price cutting caused by the unbalance of rig supply to demand. Under existing business practices, it is considered proper to take the lowest price, quality considered, even if below cost. It hasn't occurred to him that if all gasoline consumers patronized the cut price filling station, the petroleum business might be in the same financial plight as the drilling contract business.

No, because, in all fairness to him, he does not set the price; he is willing to pay a fair price. He knows the contractor is not realistic and is pricing below cost and a fair profit, and he knows that this will eventually result in the deterioration of the contractor's ability to properly handle the work and continue to improve his performance.

On the other hand, if the low bid, equipment and ability considered, is not to be accepted, who is to say which bidder is to be favored and by what standards judged? Even with the best intentions, he is still between a rock and a hard place. A company (or a contractor) cannot give a purchasing agent the leeway to disregard price in selecting the supplier.

Since the customer recognizes the contractor's indispensability and his present economic difficulties, are there any areas in which both can work to their mutual advantage?

Yes, there are, and many are cultivating them.

The contractor, through AAODC and its many committees, has, for years, devoted time and money toward the improvement of his rate of penetration, reduction of costs, promotion of safety practices, dissemination of information, promotion of better and more accurate accounting and application of modern business practices, as well as cooperation among contractors. Economic pressure of competitive prices have made the contractor aware of the necessity of these for survival and have, of course, benefited the customer through lower costs—even with a normal profit.

As to the customer, he certainly realizes that whatever unnecessary costs he causes the contractor, he must, eventually, pay himself—if not today, then tomorrow or next year. The contractor has no other source of income.

Such being the fact, he can contribute to the improvement of the contractor's economic lot without abandoning the practice of competitive bidding (if this is considered essential) in many ways. Some of these are:

- Give the contractor more than one well at a time under the same bid, when possible. The contractor can plan ahead, avoid costly shutdowns between wells, reduce moving costs and keep his crews together.
- Have locations ready in advance so as to reduce idle time.
- When two bids are approximately equal, give the work to the rig nearest the location, if the contractor will take it at the adjusted price. A penny saved in transportation is a penny earned by the industry.
- Don't ask for more or heavier equipment than necessary for the depth to be drilled. Horses cost money. Slight reductions in drilling time, so as to further reduce footage prices, should be weighed against the high cost of higher horsepower and pump capacity.
- When the customer specifies the mud program, he should keep in mind the rate of penetration as well as the protection of the hole and formations and delivery of the samples. Drilling fluids affect materially the rate of penetration and the contractor's costs.
- Don't load on the contractor all the burden for lowering the cost of the well. A few cents per foot can make the difference between profit and loss to the contractor but, many times, this can be unnecessarily spent by geological and engineering requirements. Information is fine and necessary, provided it doesn't cost more than it is worth. Remember, the cost of *drilling* the hole has gone down but the cost of *completing* the well has gone up.
- It costs money to keep a hole straight. Liberal straight hole deviations can speed drilling without adversely affecting the subsequent operation of the well—gas lift wells and gas wells, for instance. This is particularly important in areas where crooked hole problems are serious.
- Work toward adoption of a uniform drilling contract, in which the responsibilities of each party are clearly defined, dual liabilities eliminated, risks placed where they belong and both parties protected from nebulous obligations. The contractor will know when he bids the contract he will be expected to sign. Can anyone imagine how long it would take to get the signature on an oil and gas lease or casinghead gas contract if each producer or gasoline plant operator had its own form?
- When a contractor has drilled a discovery well, particularly in an isolated location, often on a break-even basis, don't reward him by taking new bids for the next well when you know his price was reasonable and performance satisfactory. What greater humiliation can one suffer than to have a rig idle while another contractor moves a long way to the offset location? Who ultimately pays the cost of the move?
- Don't always insist on the latest equipment because it looks good, is highly advertised and is good. The contractor has been operating on a basis which hasn't permitted the replacement of his equipment. At best, he has been able to replace some items. Drilling equipment is not necessarily inefficient because it is not new. Besides, historically, drilling rigs are like old soldiers—they just fade away. Under present conditions, there's no way for a contractor to pay off a new rig with its earnings.
- When a contractor drills on a footage basis and is financially responsible, let him run his job. If he does good work, tell him so. He and his men strive to please and are human.
- Then there's the problem of excess costs, over estimates and bids, caused by conditions which neither the contractor nor the customer could foresee when the contract was made. The well a few miles away, on which both parties relied, just wasn't reliable. It is simply impossible for even a good geologist to see one or two miles below the grass roots. There should be enough leeway in management and sufficient milk of human kindness in the petroleum business to permit the reimbursement of the contractor's actual cost, when the excess costs were due to conditions beyond the ken of both parties and not due to his inefficiency. There is just not enough room in prevailing prices for such contingencies.
- Preparing bids costs money, particularly for outpost or wildcat wells. It would seem wasteful and unnecessary to expose more than a half dozen contractors to such costs for each well.
- When requesting bids, it will be helpful if the type of equipment required is clearly specified and then the contract awarded to the contractor bidding with such equipment and not to another offering inferior equipment at a lower price. There's a substantial difference in operating costs and depreciation in different sizes of rigs.
- Finally, the customer might profitably consider consulting the contractor on drilling programs and problems. He has drilled millions of feet of hole under various conditions in many areas. He specializes in drilling hole at the lowest cost. He has to. His personnel and supervisors have had many years of experience and know or should know their business. He should and does know the ways of achieving the best results at the lowest cost because money comes rather hard for him. Give him credit for knowing more about drilling than just turning the rotary to the right.

We know that the drilling contracting business is here to stay, regardless of its ups and downs. It has proven its worth to both parties and has been good to the one and for the other. Many a substantial producer and valuable member of the industry started with a used rig held together with a prayer, bailing wire and a hard working toolpusher—himself.

Yes, it is here to stay, despite its good and bad cycles. We are in a bad cycle now, but the contractor is an optimist—has to be. He is increasingly conscious of the fact that he is an important member of a great industry—not just a separate little business entity immune from the problems and obligations of the whole complex petroleum structure. The faces may change, but the business will continue.

The present oversupply of rigs is the result of the postwar drilling boom. The depressed conditions followed the sudden reduction in drilling activity, starting in 1957. But rigs and contractors are wearing out and are not being replaced. Soon—a year or two—they should approach a balance and the bid price will again be the $6.75 which includes depreciation and a reasonable profit and not the $5.60 which is 10 cents lower than that of the lowest competitor.

A. W. Thompson
President
A. W. Thompson, Inc.

Johnny Mitchell
Partner
Christie, Mitchell and Mitchell Co.

Robert L. Boggs
Vice President
Gulf Oil Corp.

Fred Mayer
President
Continental-Emsco Co.

Wallace S. Wilson
Vice President
Wilson Supply Co.

What's ahead for drilling industry?

Five oil industry leaders discuss current economics and technical problems in the drilling industry and the effect they will have on the future

By Jack F. Earl, Engineering Editor, WORLD OIL

AT THE CROSSROADS of its second century of existence, the U.S. drilling industry is taking a close look at current economic and technical problems, and the effect they will have on future progress.

Clouding the picture are several disturbing factors. Equipment and personnel costs are mounting. Profit margins are getting slimmer. The trend is toward fewer and deeper wells. The need for better trained personnel is increasing.

Will the drilling industry be able to solve these problems, thus permitting oil and gas to remain the cheapest, most popular fuels for another 100 years?

Seeking answers to this highly important question, WORLD OIL has interviewed five oil industry leaders. Their opinions are expressed on the following pages:

1. *What is your biggest drilling cost problem? What do you think can be done to reduce it?*

Thompson says that the "biggest costs in our drilling operation is labor and materials, with labor as the largest single item. Improved training methods would be effective in decreasing labor costs."

Thompson and Mitchell agreed that rock bits are the most costly of all the materials expense items, and pointed out that bit manufacturers are developing new bearing designs which should result in over-all reduction in bit costs.

Boggs suggested that "it will take some outstanding break throughs in the basic approach to really accomplish a sufficient reduction in drilling costs to result in any major reversal in the over-all downtrend in drilling activity in the U.S." He said new drilling techniques, such as air drilling, should reduce drilling costs.

2. *What can be done to improve supplier-drilling contractors relationship?*

Thompson expressed the opinion that "contractors are receiving too many 'so-called' free services from the supply company in the way of field deliveries, etc., that are costing the operators and contractors excessive amounts." He said closer cost evaluation of these services by the suppliers would be most helpful in reducing costs. One solution of this, he suggested, is to establish FOB store and delivered prices.

Boggs, however, said "it would be hard to beat the present relationship as, in most instances, the basis of coordination and cooperation of effort now exists."

Mayer concurred with Boggs as to the over-all relationship. But, he indicated there is room for improvement,

he said, "The acceptance of a more standard design and fewer gadgets on drilling equipment should be possible and reduce the prices. Ever rising costs have resulted from different and varied ideas of the engineers of purchasing concerns. Some slight change may have a little merit, but it should be weighed against the extra cost not only on the specific piece of equipment but also on the over-all additional costs entailed by a company in maintaining heavier forces of engineers to work on varied demands."

Recognizing that "costs of field deliveries continue to mount, in part, due to increasing demands for such services," Mayer said emergency and rush orders will always exist and, under any conditions, the supply industry is always eager to handle them. However, he suggested that whenever possible such rush orders should be held to a minimum since economics are affected when business is handled in a routine manner without the expense of additional communications, handling, transportation and overtime pay.

Continuing, Mayer said that when trading in old equipment on new purchases the contractor should limit efforts to trade such equipment for that with economic value. "Junk equipment should be junked rather than attempt to trade in to a supplier," he said.

Wilson expressed the view that "the relationship is a very healthy one."

"To be of real service," he said, "the supply man must have technical know-how and must keep up to date on the new products and new methods so the contractor may be properly informed." Meetings of the contractor's field men with factory trained technicians to explain equipment changes, usage and maintenance are very helpful, he added.

Mitchell called "a more thorough understanding of the many problems that a contractor today must face in his competitive field" the most important requirement between the supplier and drilling contractors.

He mentioned that a new group of contractors has started in the business and that supply houses are in the contracting business and are competitors to the reliable independent contractors who have operated for many years.

3. *What can be done to improve operator-drilling contractor relationship?*

The concensus is that responsibilities and requirements should be more clearly ascertained and agreed upon by each party before actual bidding, moving in, drilling, completing, and moving out operations.

Boggs said, "The more basic data available for a contractor to use in estimating his bid, the better the bid will be because of the reduction in the charges for risks and uncertainties."

Thompson concurred with Boggs in that an API Standard Contract with uniform bid sheets should be adopted for use in the industry. Separate specification sheets applying to specific areas of operation could be attached to the standard forms. He explained that to his knowledge the industry has been working on this project for the past 20 years; however, he described the progress as slow but badly needed within the oil industry.

Mitchell emphasized the point that "it is obvious to all operators that drilling contractors, as a rule, are immune to all the damages caused by them to property on which they are in the process of drilling and completing a well. On too many occasions loss of livestock, damages to crops and upkeep of roads are completely ignored by the drilling contractor."

He suggested that the American Association of Oilwell Drilling Contractors set out the contractor's responsibilities to the property owners upon whose lands they are drilling.

Mitchell also stated that "most operators normally rely on the cheapest bid in the drilling of their wells. Truly, producers must be cost conscious," he said, "but in their bids they should be conscientious in negotiating their bids by using reliable, competent contractors."

Mayer expressed the feeling that "the operator must begin to see that the contractor receives compensation commensurate with his investment and knowledge of the risk he takes. The operator should insist that the contractor has first class equipment, be financially capable of meeting his obligations, be an efficient operator and pay him a price that will keep him in business."

4. *What phase of the drilling industry needs the most improvement?*

Boggs, Thompson and Mayer all agreed that better trained drilling crews is a matter of importance. Most major accidents and a large percentage of the small but costly mistakes in drilling can be attributed to personnel failures due primarily to inadequate training of personnel as opposed to a failure of equipment or improper design, they believe.

Thompson mentioned that "drilling techniques are always open for improvement and special emphasis should be given to the proper use of drilling fluids."

5. *What new improvement in drilling equipment or operational standardization are you interested in?*

Mitchell pinpointed operational standardization as the solution to the contractor's problem as well as the operator's. That is, he said, more oil must be recovered to insure the operator a reasonable return for his investment. This may be accomplished, he said, by drilling fewer wells in proven reservoirs (wider well spacing). When an operator recovers more oil or gas from each well, then and only then, is he able to pay the drilling contractor a fair price, somewhat above the present competitive level, that will insure the contractor a reasonable profit, he concluded.

Mayer said his company, as well as others, is spending large sums of money in research and development on various methods and drilling equipment. These projects include light weight equipment, better drill pipe and down-hole powered rotary equipment.

"American Petroleum Institute should continue in the attempt to standardize blowout equipment, blowout hook-ups, and drill collars," Thompson said. Also, he suggested a standardization of hole sizes. He referred to the approximately 746 different sizes and types (50 different sizes) of rock bits.

"Why is this necessary when a maximum of 10 bit sizes could meet the greatest percentages of drilling programs presently being followed," he commented, adding that "this is certainly an area where cost reduction could readily be realized." —The End

Why does drill pipe fail in the slip area?

Proper pipe handling methods and understanding "crushing force" between pipe and slips can reduce drill pipe failures in slip area

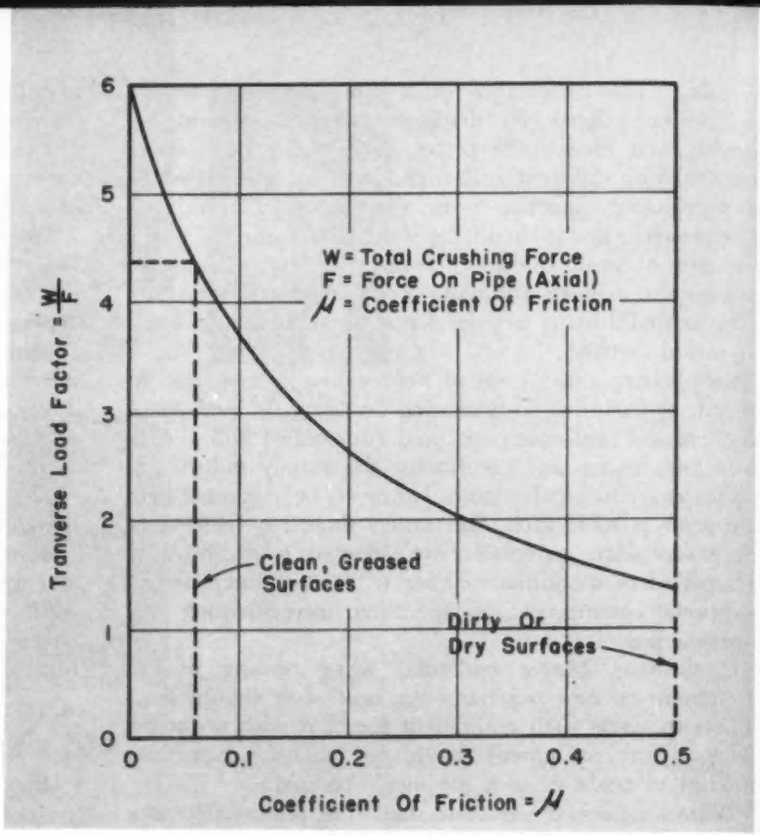

FIGURE 1—Plot of $\frac{W}{F}$ vs. M^{μ} for an API taper.

By Walter B. Reinhold, Owner
W. H. Spiri, Chief Engineer
Abegg and Reinhold Company
Los Angeles

As drilling depths continually increase and hydraulic efficiency demands the use of 4½-inch or 5-inch O.D. drill pipe down to completion depth, greater hook loads encountered are drawing attention to drill pipe failures occurring in the slip area.

An analysis of these failures has revealed that they are caused by several factors and that in all cases such failures can be classified and minimized by use of proper equipment and handling techniques.

The following conclusions about drill pipe failures and theoretical calculations have been made:

- Drill pipe failures in the slip area are caused by:
  1. Highly concentrated stresses originating from axial and transverse loads that are not equally distributed over the full gripping surface of the slip.
  2. Improper handling methods which result in abnormal marking and stressing in the slip area.
- Drill pipe failures in the slip area can be prevented by maintaining rotary master bushings and slips to correct API specifications and by good handling techniques.
- Transverse loading varies inversely with the coefficient of friction between the contact area of the slips and master bushings (see Figure 1). Therefore, it would be good practice to maintain a dry condition between slips and master bushings for optimum friction and minimum lateral loading.
- Maximum axial and transverse loads do not act at the same cross section in the slip area. The critical section occurs at the zone of maximum crushing pressure, and at this point the axial load is less than the hook load (see Figure 2).

Therefore, the calculated axial load versus the transverse load factor must always be considered when designing a drilling string where excessive hook loads are expected. As can be seen in the curve in Figure 3, it is vitally important to understand that the presence of transverse loading diminishes the total load, in pure tension, necessary to start yielding. Therefore, minimum properties based on tension yield only are not sufficient in the determination of adequate strength factors for drilling strings.

- Oil and gas wells can be drilled successfully with 4½-inch, 16.6 pound per foot, Grade E drill pipe approaching hook loads somewhat greater than 250,000 pounds, provided rotary slips and master bushings are maintained to API specifications and good handling techniques are used. When drilling conditions indicate axial loads approaching and in excess of 300,000 pounds, 4½-inch, 20.0 pounds per foot, Grade E drill pipe should be used above the conventional string.

Transverse loading and crushing force between the drill pipe and rotary slips, is generally overlooked. The transverse load, created by rotary slips working in combination with the master bushing, is always greater than the total vertical or hook load. This transverse load acts as a compressive force on drill pipe and, given adverse conditions of equipment or handling techniques, bottlenecking or crushing will occur

when excessive hook loads prevail. This condition exists because the collapse strength of the drill pipe in the slip area is exceeded.

Master bushing wear is trouble source. Standard API dimensions for master bushings are shown in Figure 4. All master bushings should be inspected carefully, periodically repaired and then maintained to conform with these API standard dimensions. Also, rotary slips likewise should be carefully inspected, repaired and maintained to properly fit and conform to API standards. Figure 5 illustrates the results of using worn master bushings in a worn rotary table.

Due to wear and pressure from split master bushings, the I.D. of the rotary table eventually will become worn and distorted. If master bushings with worn backs and bowls work in combination with a distorted, worn rotary table, the correct API master bushing bowl taper will not be maintained and will prevent the slips from receiving proper backing.

The slips will spread in the enlarged throat of the master bushings and will contact the pipe with only a partial area of their gripping elements. This action will result in unnecessary marking of pipe and if the hook load is sufficiently heavy, bottlenecking will occur because the total transverse load will be concentrated in a relatively small section rather than being distributed over the full length of the slip.

Figure 6 illustrates the results of using new master bushings in a worn rotary table. Unfortunately, if the rotary table is worn and distorted, the new split master bushings will immediately spread and conform to the incorrect dimensions of the table.

To correct this condition, it is necessary to build up the I.D. of the rotary table before installing new split master bushings. An alternative and less expensive method is to use solid type master bushings which are not dependent on the I.D. of the rotary table for support. Figure 7 illustrates the results of employing

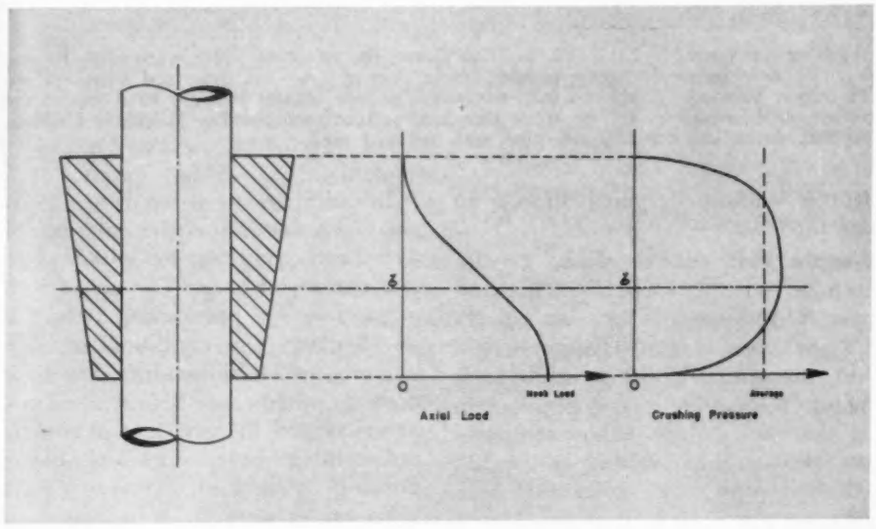

FIGURE 2—Schematic illustration above shows the probable distribution of average crushing force and axial load.

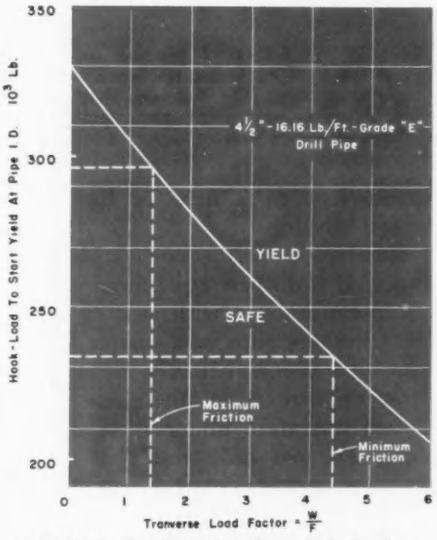

FIGURE 3—Calculated axial load vs. transverse load factor.

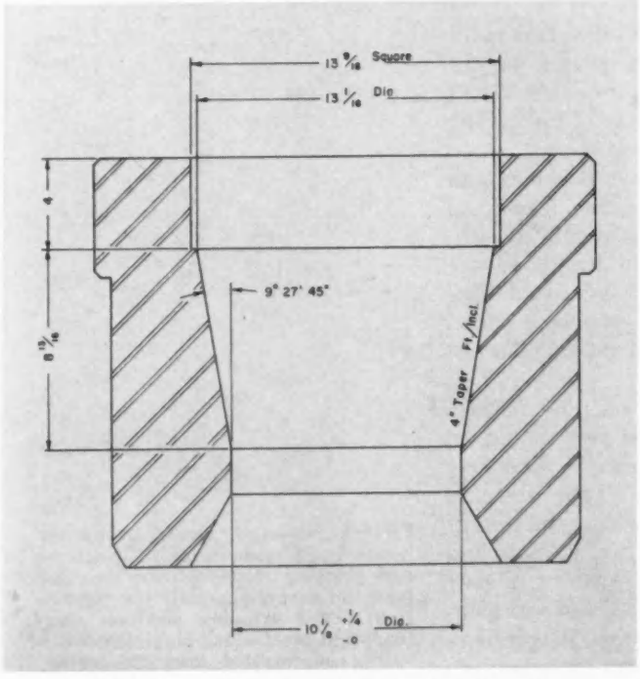

FIGURE 4—Cross-section of standard API bushing.

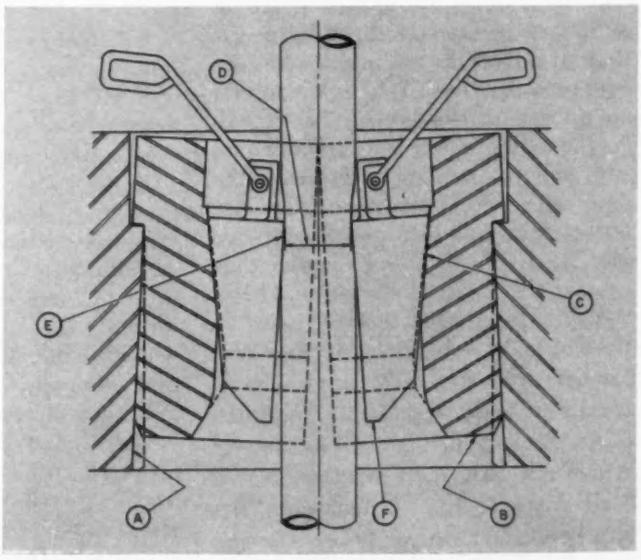

FIGURE 5—Cross-section of worn master bushing and worn rotary table. Worn table is shown at (A); worn split master bushing at (B). Arrow at (C) indicates that correct API master bushing bowl taper is not maintained; (D) shows bottlenecking of pipe; and (E) shows how actual gripping area of slips is greatly reduced. (F) shows rotary slip spread, not contacting pipe with lower gripping elements.

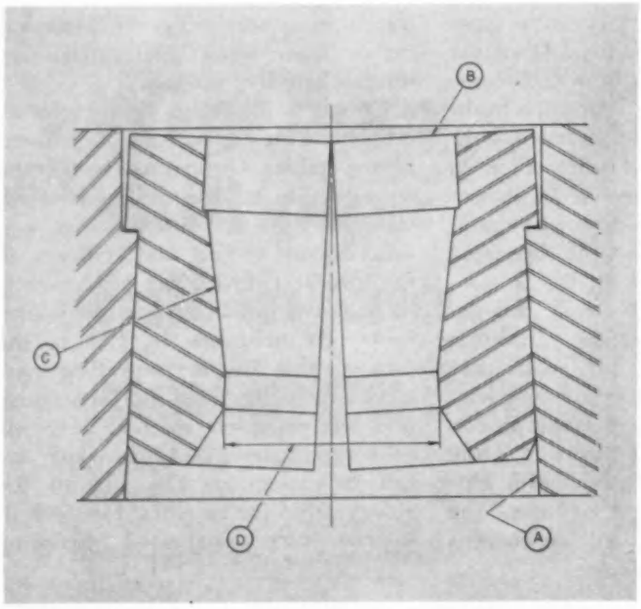

FIGURE 6—Effect of putting new master bushing in worn rotary table. (A) indicates worn rotary table; (B) new split master bushings; (C) indicates that correct API master bushing bowl taper is not maintained; and (D) shows master bushing spreads at lower end of taper, allowing slips to sink down and also spread.

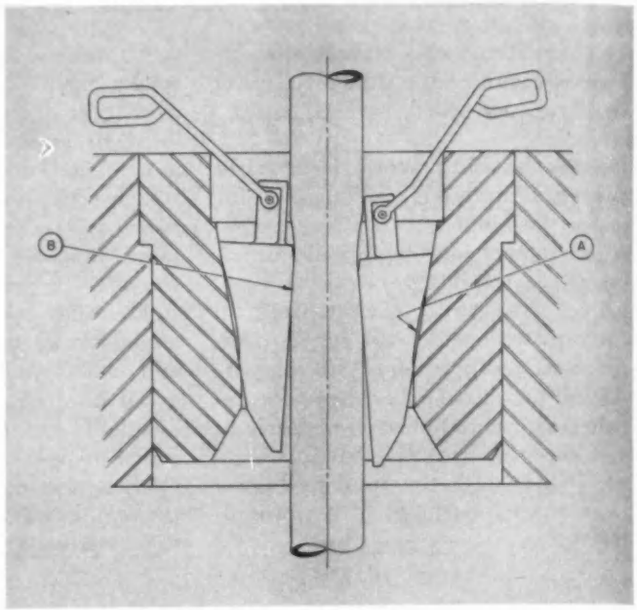

FIGURE 7—This shows the effect of using worn slips in new master bushing. Note that at (A) the deformed slips are not able to take advantage of new master bushing bowl taper; and at (B) worn slips assume incorrect position in master bushing, gripping pipe with reduced area.

worn slips in a new or like new master bushing.

Satisfactory performance cannot be expected from new equipment installed in conjunction with used or worn tools because slips and master bushings are mechanically dependent upon uniform API dimensions. Continued operation under these conditions will not only result in costly damage to pipe, but it also will ultimately deform good master bushings.

The hazards of using resharpened gripping elements in rotary slips is illustrated in Figure 8. New gripping elements are manufactured by precision machinery to conform to the specific pipe diameter. When new inserts are placed in slip bodies that are in good condition, they transmit an equal and uniform holding pressure to the pipe. However, resharpened dies are not uniform and exact in dimensions, and when placed in slip bodies they protrude at unequal distances. Therefore, the pipe would be held only by those inserts which protrude the farthest and they will carry a concentrated load, penetrating the pipe.

At the same time, those inserts which are carrying the concentrated load may be forced back into the slip bodies deforming the seats of the recesses which hold them in the slips. When the recesses have been damaged, slips are destroyed because even new inserts may set back in the deformed recesses and will not present a uniform gripping surface to the pipe.

Simple test checks slips. To determine whether rotary slips and master bushings conform to correct specifications, a relatively simple field test procedure is being used. It is based on the effective gripping action of the rotary slips. Many toolpushers whose rigs are drilling in the 12,000-foot plus range make this periodic test:

- Pick up the kelly and set slips below the usual slip area on drill pipe.
- Pick up, remove slips and carefully examine gripping area to determine length, circumferential amount, and uniformity of holding by the gripping elements.

If the rotary master bushings and slips are in good condition, a uniform gripping pattern can readily be observed, matching the length of the slip being employed. Under such conditions, the total transverse load would be equally distributed over the maximum slip area.

If only a partial gripping pattern is observed, the same test should be repeated, using a new or like new set of rotary slips. If the gripping pattern then is uniform, the rotary slips currently used are at fault and should be repaired. However, if new slips do not transmit a uniform gripping pattern to the pipe, it is indicative that the master bushings are worn and they should be repaired.

In addition to these tests, gages also can determine the amount of wear and condition of rotary slips and master bushings. The use of such gages can be particularly effective in checking the condition of slips and master bushings after they have been repaired and before they are again placed in service. Continually maintaining rotary slips and master bushings in new or like new condition assures that the transverse load will be distributed over the maximum

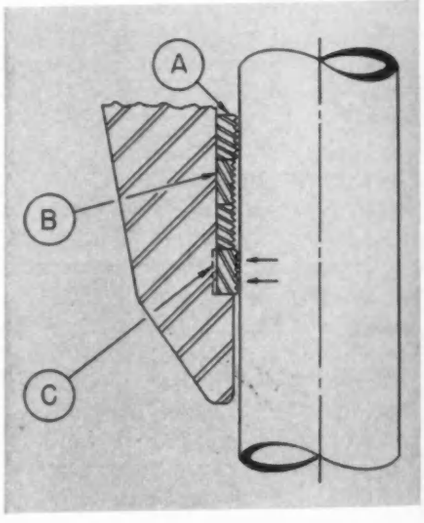

FIGURE 8—Resharpened gripping elements are hazardous. At (A), new or like new gripping elements carry concentrated load and deeply penetrate the pipe; at (B) resharpened gripping elements carry no load; and at (C) gripping elements which carry concentrated load are forced into slip bodies resulting in permanent damage to slips.

slip area, rather than being concentrated in a relatively small section.

Poor operating practices injure pipe. Proper handling techniques play an important part in the prevention of damage to drill pipe in the slip area. Figure 9 illustrates the results of stopping the downward motion of the drill pipe with slips instead of the brake.

This subjects the area of the drill pipe immediately beneath the last gripping element of the rotary slips to an increased tensile loading which, if the weight is sufficient, will elongate the drill pipe in this area. This elongation actually yields pipe and renders it useless.

The results of accidentally catching tool joints with drill pipe slips is illustrated in Figure 10. In the event of such an accident, slips should be immediately inspected for breakage and cracks. Abnormal stresses are transmitted to slips caught in this position, and unless slip bodies are restored to proper dimensions, they will not fit correctly around the pipe in the master bushings. Damage also can be inflicted on rotary slips by accidentally sitting on them with elevators. Serious damage to the drill pipe can result from:

- Letting rotary slips ride the pipe
- Using slips designed for one diameter on different diameters
- Using only one tong when breaking out or making up
- Rotating pipe with slips

Handling Problems For High Strength Drill Pipe

Methods for handling high strength drill pipe—now proposed or used—will be discussed in the November issue of WORLD OIL.

Procedures include:

- Double elevator system
- Double insert system
- Lifting plugs per stand of pipe
- Handling subs or elevator subs
- Double shoulder tool joint system
- Application of a plastic to the slip area

Transverse loading—with friction. It is assumed that motion between the slip and master bushing is impending. Consider the slip cross-section with the forces designated in Figure 11 as follows:

F = total vertical pipe load
W = total crushing force between pipe and slip,
R = total normal force, μR = total friction force between master bushing and slip.

(These forces are distributed over the lateral surfaces of the slip)

The following two equations must be satisfied for equilibrium of the slip:

$W = R\ (\cos\alpha - \mu\sin\alpha)$,
$W = R\ (\sin\alpha + \mu\cos\alpha)$.

Eliminating R from these equations gives:

$$W = F\frac{(1 - \mu\tan\alpha)}{\tan\alpha + \mu}$$

When $\mu = 0$, and $\tan\alpha = 1/6$ (API Standard taper angle)
$W = F/(\tan\alpha) = 6F$
When $\mu = 0.06$ (Lowest value for greased metal surfaces),
$W = 4.37F$

It has been shown that, neglecting friction, the transverse load is six times the vertical hook load. However, calculations indicate the importance of friction and demonstrate that an error greater than 37 percent is introduced when friction is neglected. The coefficient of friction may vary between 0.06 and 0.5, and the transverse load factors (W/F) for μ in these limits are shown in Figure 1. A small amount of friction is very effective in reducing the crushing force on pipe, therefore, friction must

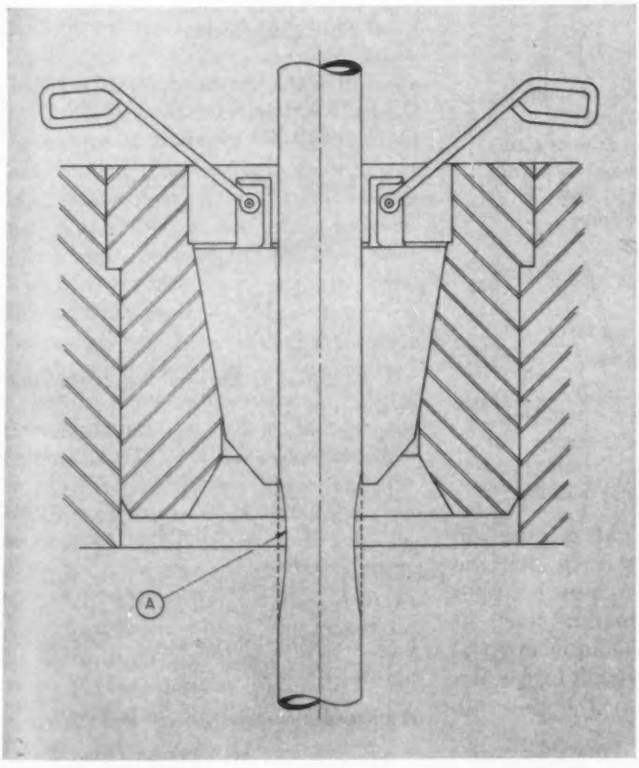

FIGURE 9—Effect of stopping drill pipe travel with the slips. Section of drill pipe at (A), just below the last gripping element, is subjected to an increased tensile loading, and if the weight is sufficient, yielding will occur.

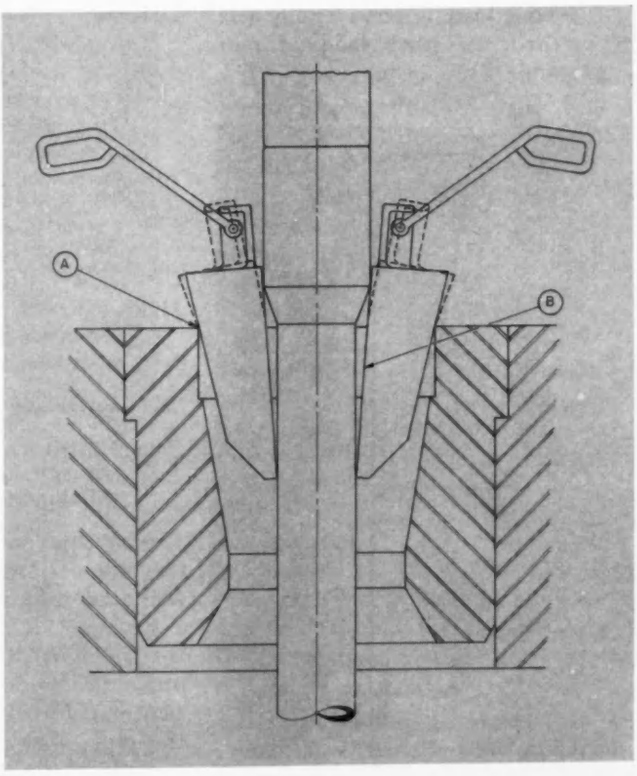

FIGURE 10—The illustration above shows the effect of catching tool joint with the slips. Backs of slips at (A) are cracked or deformed; and gripping surface of slip at (B) is cracked or deformed.

always be considered when calculating transverse loading.

CALCULATING STRESSES IN DRILL PIPE HELD IN SLIPS

I. Assumptions:

A The segment of pipe in the slip is unrestrained at the top and bottom of the slip.

- Assumption (A) neglects the constraint due to the pipe above and below the section in the slips. The constraint opposes collapse of the pipe. It is, therefore, a conservative assumption.

B The full hook load and the average slip crushing pressure act at the same cross section.

- Actually, the average crushing force and the full hook load do not act at the same cross section. The probable distribution is schematically illustrated in Figure 2. The full hook load (maximum axial load in the pipe) acts at the bottom of the slip where the crushing pressure is zero. The critical section is somewhere between the bottom of the slip and section (b) where the maximum crushing pressure occurs (critical with respect to failure of the pipe). The axial load is considerably less than the hook load at section (b).

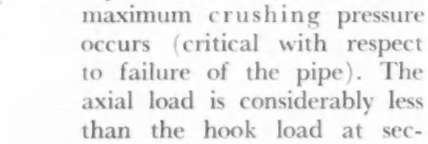

FIGURE 11—Transverse loading with friction is calculated by considering the slip cross-section and designated forces.

C Huber-Hincky-von Mises (shear) distortion energy) criterion of failure of pipe or casing applies.

D Buoyancy is neglected.

E Solid type master bushings and rotary slips having new API tapers are used.

II. Calculation of hook load which causes yielding to start in the pipe.

A The failure criteria may be written as follows:

$$(O_x - O_r)^2 + (O_x - O_\theta)^2 + (O_r - O_\theta)^2 = 2\,O^2_{yp} \qquad (1)$$

where O_x = axial stress $= \frac{F}{A}$

O_r = radial stress at radius r $= \frac{wb^2}{b^2 - a^2}\left(\frac{a^2}{p^2} - 1\right)$

O_θ = circumferential stress $= \frac{wb^2}{b^2 - a^2}\left(\frac{a^2}{r^2} + 1\right)$

O_{yp} = yield strength of pipe

F = axial force in pipe

A = cross sectional area of pipe

w = external pressure on pipe

b = outside radius of pipe

a = inside radius of pipe

and $w = \frac{W}{A_L} = \frac{KF}{A_L}$

where

W = lateral crushing force

A_L = lateral slip area

K = lateral load factor $= \frac{1}{\tan(\alpha + \varphi)}$

φ = friction angle $= \tan^{-1}\mu$

μ = coefficient of friction between slips and master bushing.

When the stresses at a point in the pipe are increased such that the left hand side of equation 1 equals $2\,O^2_{yp}$, plastic deformation starts at that point. The combination of axial and crushing load which just starts plastic deformation at the point in the pipe where

$$(O_x - A_p)^2 + (O_x - O_\theta)^2 + (O_r - O_\theta)^2$$

is a maximum will not produce a measurable permanent reduction in pipe diameter.

Such reduction in diameter occurs when the loads are increased sufficiently to cause yielding to progress through the pipe wall. A plastic-elastic analysis would have to be employed to determine the hook load required to cause a measurable reduction in pipe diameter.

B Application of equation 1 above to an element on the outside gives:

$$\left(\frac{F}{A}\right)_{O.D.} = \left[\frac{2}{\left(1 + \frac{KA}{A_L}\right)^2 + \left(1 + \frac{a^2 + b^2}{b^2 - a^2}\frac{KA}{A_L}\right)^2 + \left(\frac{2a^2}{b^2 - a^2}\frac{KA}{A_L}\right)^2}\right]^{1/2} O_{yp} \qquad (2)$$

For element on the inside diameter of the pipe:

$$\left(\frac{F}{A}\right)_{I.D.} = \left[\frac{2}{1 + \left(1 + \frac{2b^2}{b^2 - a^2}\frac{KA}{A_L}\right)^2 + \left(\frac{2b^2}{b^2 - a^2}\frac{KA}{A_L}\right)^2}\right]^{1/2} O_{yp} \qquad (3)$$

It may be seen that $\left(\frac{F}{A}\right)_{I.D.} < \left(\frac{F}{A}\right)_{O.D.}$, so the critical element is on the inside of the pipe (smaller load will start yielding).

III. Examples: Pipe—4½ inch, Grade E, 16.6 pounds per foot

A = 4.407 square inches

A_L = 226 square inches

b = 2.25 inches

a = 1.91 inches

O_{yp} = 75,000 psi

$O_{yp}\,A$ = 330,500 pounds

A. Case: $\mu = 0$, K = 6

$$\frac{KA}{A_L} = 0.117, \quad \frac{KA}{A_L}\frac{2b^2}{b^2 - a^2} = 0.85$$

$$\left(\frac{F}{A}\right)_{I.D.} = 0.623\ O_{yp}$$

F = 206,000 lb. to start yielding at the pipe I.D.

B. Case: $\mu = 0.3$ K = 2.04

$$\frac{KA}{A_L} = 0.0398, \quad \frac{2b^2}{b^2 - a^2}\frac{KA}{A_L} = 0.288$$

$$\left(\frac{F}{A}\right)_{I.D.} = 0.854\ O_{yp}$$

F = 282,000 lb. to start yielding at the pipe I.D.

A plot of F vs K is shown in Figure 3.

Hook loads of 250,000 pounds can be handled safely using 4½-inch, 16.6 lb/ft Grade E drill pipe. Because

Continued on Page 115

Penetration rate increases with larger drill collars

Hole size and configuration are influenced by bottom hole assembly and drilling rate

By H. E. Treichler, Owner
HET Drilling Company
Houston

WHEN DRILLING with conventional rotary tools by conventional methods, a bit follows a spiral path (in traversing any vertical distance) through a homogeneous section. This spiral path is not a simple one where a long section of hole is concerned. However, for short sections of hole it can be regarded as a simple spiral in which the diameter is controlled by the resistance of the formation to the horizontal movement of the drilling tools.

Drill collars are evenly worn. Evidence of the existence of this spiral is the nature of the wear on drill collars used in drilling wells in formations having low compressive strength (formations having low resistance to horizontal movement of the tools). These drill collars are worn equally over their entire length. The lower end of the collars is, then, in contact with the wall of the hole during the drilling operation. The conventional drilling hook-up consists of drill collars having a considerably smaller diameter than the bit. Where there is no change in angle or direction of the average center line of the hole, as indicated by surveys, and where the drill collar immediately above the bit has been in contact with the wall of the hole during the drilling operation, the bit must have followed a spiral path.

An analysis of the forces acting on the bit during the drilling process also indicates that this would occur. Weight on the bit is applied by a limber string of drill collars. The diameter-length ratio is such that the drill collars will not act as a stable column. The weight on bottom, as indicated by the weight indicator, actually is divided into a vertical and a horizontal component at the bit (Figure 1). The division of these two forces would depend upon the degree of buckling of the collar immediately above the bit.

Torque applied to the drill string when transmitted to the bottom of the hole by the bit results in a reaction tending also to make the bit move laterally.

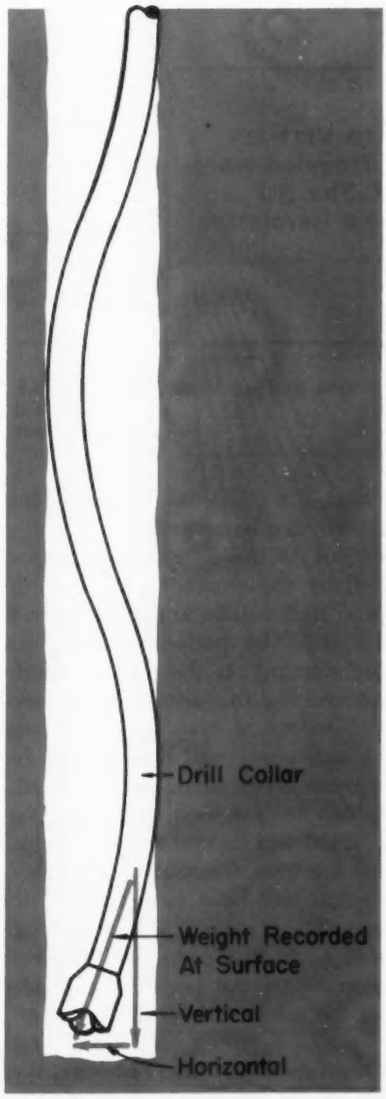

FIGURE 1—Here are shown the forces which act on the bit when weight is applied.

Friction of the rotating drill collar against the side of the hole creates a reaction tending to make the drill collar roll around the wall of the hole in a direction opposite to the direction of the rotation of the bit. A combination of these forces obviously creates considerable horizontal force at the bit during the normal drilling operation. Inspection of drill collars used in formations having low compressive strength indicates this force is great enough to keep the drill collars immediately above the bit in contact with the wall of the hole.

Terms must be defined. For thorough understanding of the phenomena that result while drilling a hole, the following terms must be defined; radius, period, and pitch of the spiral.

The radius of the spiral is that horizontal distance that the center line of bit travels away from the average center of the hole. If formations penetrated have sufficient compressive strength and if the small cross-section of the bit has a stabilizing effect, this radius will be small.

However, if the formation has a low compressive strength and will not allow the body of the bit to act as a stabilizer and when the drill collars are subject to little or no buckling, this radius will be equal to one-half the difference between hole size and drill collar size. Where the compressive strength of the formation is low, but drilling conditions are such that the collars buckle appreciably immediately above the bit, this radius will be limited only by the rigidity of the collars.

The period can be defined as the time required for the point of contact between the drill collars and the side of the hole to revolve one time around the circumference of the hole. This

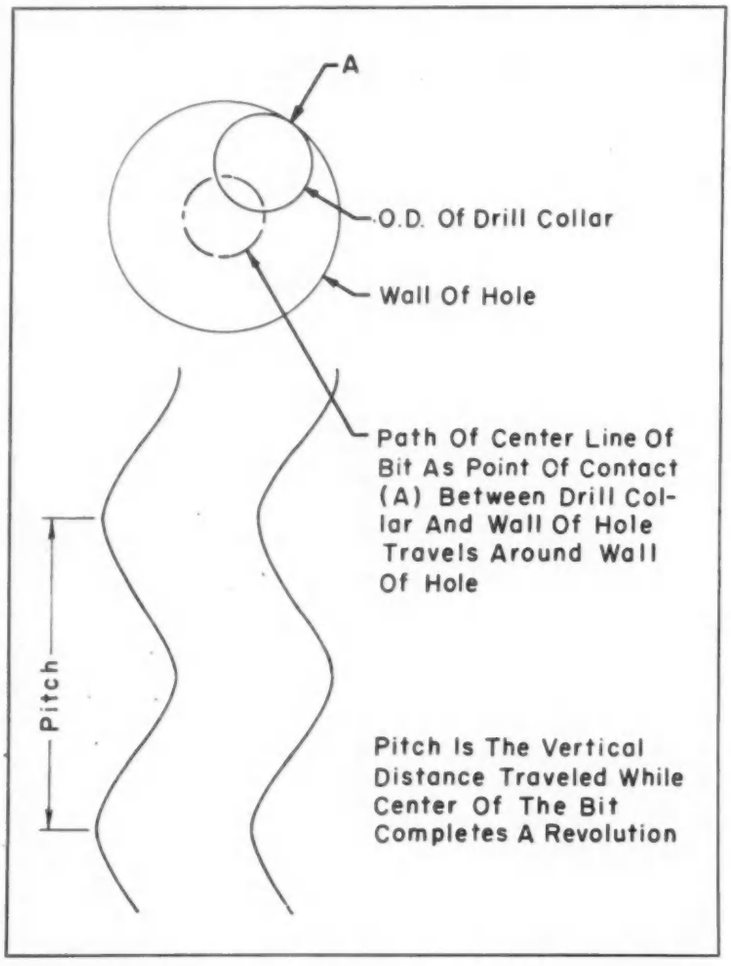
A
O.D. Of Drill Collar
Wall Of Hole
Path Of Center Line Of Bit As Point Of Contact (A) Between Drill Collar And Wall Of Hole Travels Around Wall Of Hole
Pitch
Pitch Is The Vertical Distance Traveled While Center Of The Bit Completes A Revolution

FIGURE 2—A schematic drawing of the cross section and spiral configuration of the hole is shown above.

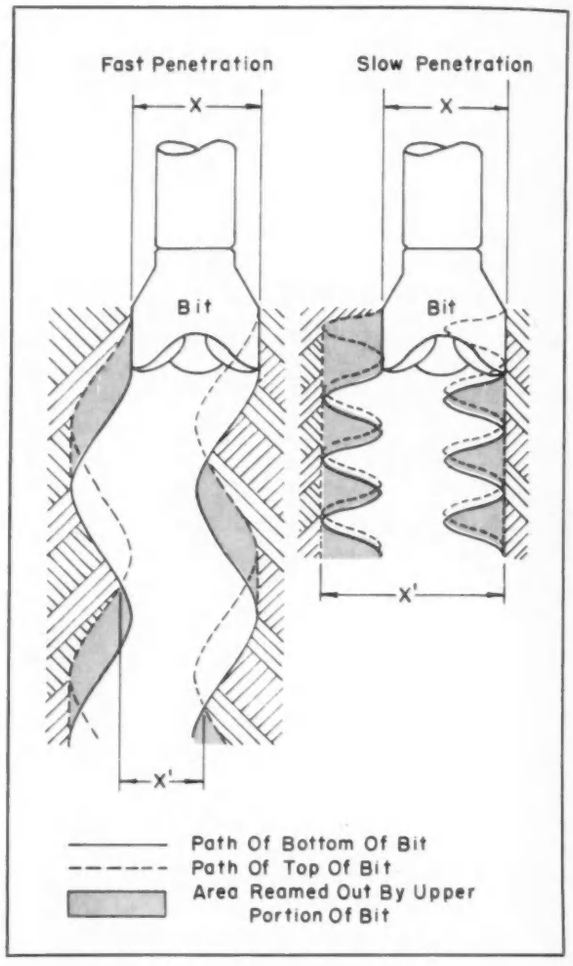

FIGURE 3—Hole size will vary with rate of penetration. The faster the penetration the smaller the hole, and conversely, the slower the penetration of the hole.

will vary with rotary speed and torque, ranging from a low equal to the rpm of the rotary, to a high of as much as three minutes. This upper limit is not known. It is an estimate based on field observation.

The pitch of the spiral is the vertical distance traveled by the bit during this period (Figure 2). If the period is equal to the rpm of the bit, an extreme condition results. This has been observed in the field and is known as a "bit drilling off center."

This condition has been observed on rare occasions as evidenced by the fact that a flat place was worn on the drill collar above the bit. Since the wear usually is uniform around and over the length of the collars, the period of the spiral normally will be less than the rpm of the bit. If the radius pitch and the period of the spiral path are controlled so the spiral distance traveled is equal to the vertical distance traveled, the efficiency of the drilling operation can be controlled.

Radius of the spiral can be controlled by the clearance between the bit and drill collars and by the use of stabilizers. The period of the spiral would depend on the radius of the spiral and the magnitude of the horizontal forces at the bit. Additional work and study will be required before these factors can be evaulated.

It can be assumed, however, that the period will be constant if all other forces are held constant. The pitch of the spiral will be a function of the penetration rate. If the penetration rate is high, the pitch will be long. Conversely, if the penetration rate is slow, the pitch will be short.

Evaluation of drilling records. Well 1 (Table 1) shows a decrease in penetration rate of 44 percent when changing from an 8-inch collar to a 7½-inch collar, while an increase of 155 percent was observed when going from the smaller to the larger collar. The contractor felt the drilling practices rpm, weight on the bit, and hydraulics were the same for both drill collar sizes and did not contribute to this difference in penetration rate. Also, the lithology was fairly constant for the entire interval.

After realizing that a change in drill collar size actually affected the penetration rate, as was observed in the above well, it was believed that additional examination of previous wells having a drill collar change was necessary.

On Wells 2 through 7, 12¼-inch bits were used with no special attempt being made to keep the rotary speed, weight on the bit, or other factors constant. A consistent decrease in the percentage of penetration was observed. This figure varied from 12 to

TABLE 1—Comparison of the penetration rates when different sizes of drill collars are used.

Well	Parish	DEPTH From	DEPTH To	Hours	Drill Collar Size	Drlg. Rate Ft/Hr	Percent Change
No. 1	Cameron	12,497	12,603	21	8″	5.5	
		12,603	12,647	14	7½″	3.1	— 44
		12,772	12,809	15	7½″	2.5	
		12,809	12,938	20	8″	6.4	+155
No. 2	Acadia	8,600	8,960	21	9¾″	17.2	
		8,960	9,265	32½	7¾″	9.4	— 45
No. 3	Calcasieu	8,648	9,106	27	9¾″	16.4	
		9,106	9,387	20	7¾″	14	— 12
No. 4	Vermilion	8,881	9,172	18½	9¾″	15.7	
		9,172	9,607	25½	7¾″	17	+ 12
No. 5	Terrebonne	10,547	11,022	36	9¾″	13.2	
		11,022	11,127	18	7¾″	5.8	— 56
No. 6	Acadia	9,562	10,048	31	9¾″	15.6	
		10,048	10,350	30	7¾″	10.1	— 35
No. 7	Vermillion	10,017	10,293	13	9¾″	21.5	
		10,293	10,659	23½	7¾″	15.6	— 23

56 percent. This change was evident in all the wells that were observed except for Well 4. In this case, weight on the bit was increased at the same time the drill collar size was changed which was believed to be the reason for the increase in penetration rate.

Actually, at the time wells 2 through 7 were being drilled, the contractor was not aware that this condition (a decrease in drill collar size decreased the penetration rate) existed; however, in view of this evaluation and the results of Well 1, the contractor is contemplating using one 10¾-inch collar (just above the bit) on the next 12¼-inch hole. It is felt that this change in drilling practice not only will increase the penetration rate but also will possibly result in a larger size hole.

Hole can be smaller than bit. Figure 3 shows that if the pitch of the spiral is long, the effective hole size through the pitch is equal to the bit size less one-half the difference between bit size and drill collar size. Reflection on this fact will explain why many large strings of casing would not go to bottom. Effective hole size is controlled in this circumstance as much by drill collar size as by bit size.

Hole can be larger than bit. Figure 3 shows that where the pitch of the spiral is short enough, a larger than bit size hole is drilled. This, in itself, is not serious; however, an examination of Figure 4 shows that as the pitch of the spiral decreases, the vertical distance traveled becomes a smaller and smaller percentage of the total travel. This figure is a plot of the ratio of the straight line distance between two points to the spiral distance between these points, plotted on the vertical axis as compared with pitch or straight line distance on the horizontal axis. Curves are drawn for spirals having radii as shown. This chart cannot be used quantitatively because a change in drill collar size will cause other changes. It does, however, illustrate the order of magnitude of change that might be expected in rate of penetration with change in drill collar size.

Drill collar size influences penetration rate. If the conditions in a given formation are such that the rate of penetration results in a spiral with a pitch of 8 inches and the drill collars are 4½-inch smaller than hole size, we see from point A (Figure 4) that the ratio of straight distance to spiral distance is 0.5 (two feet are being drilled for one vertical foot). If a collar 2 inches larger in diameter is used, it is found that at point B the ratio would be about 0.79. It follows,

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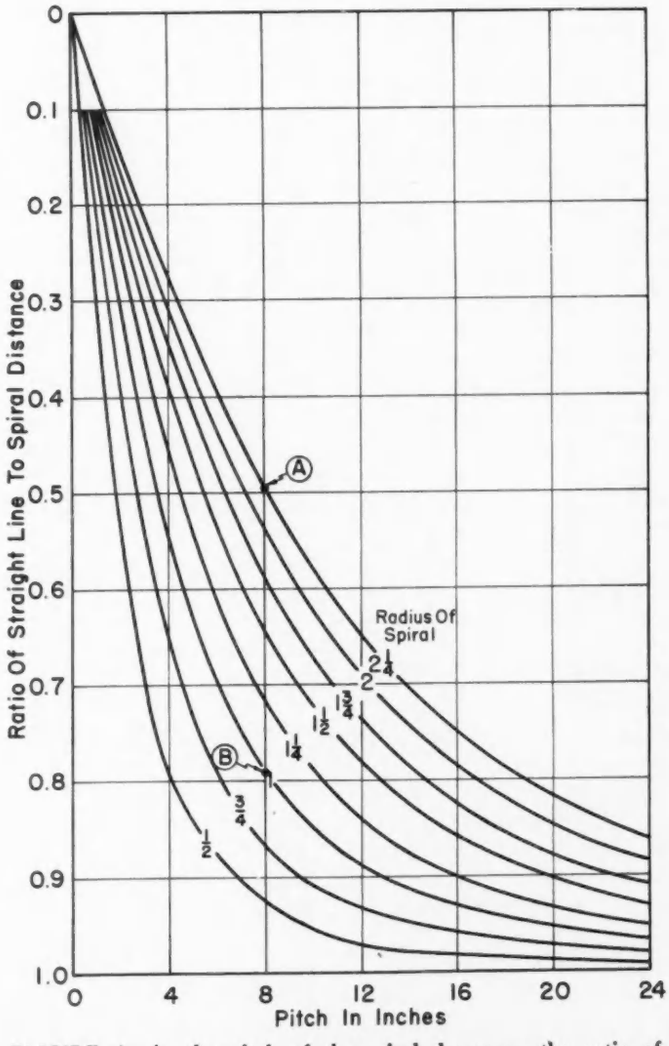


FIGURE 4—As the pitch of the spiral decreases, the ratio of the vertical distance to the total distance decreases and as the radius of the spiral decreases, the ratio of the vertical distance traveled increases.

How to drill and complete wells on the ocean floor

New sub-sea completion techniques require minimum equipment investment for contractor and operator

By David Guinn, Division Engineer
Shaffer Tool Works
Houston

AFTER FOUR YEARS of experience, many inherent problems in drilling from floating vessels have been overcome. During this time, approximately 500 wells have been drilled at sea in water depths to 400 feet. Many of these holes were bottomed below 6,500 feet and some below 11,000 feet.

Methods of drilling from a floating vessel vary as to the type of operation, area of operation and amount of drilling and pressure control desired by the operator. Tools used in sub-sea drilling are not new to the industry, but standard tools that have been adapted to sub-sea techniques. Since these tools are used on the ocean floor, they require some of remote operation. Desirable factor in the sub-sea drilling method are:

- Increased flexibility with water depth.
- Pressure control equipment is in a position of minimum motion.
- Well control is maintained even during rough seas.
- Wells can be completed on the ocean floor or on the surface.
- Low equipment cost per well.
- Location preparation is not necessary.

Many factors enter in the economics of this type of operation for exploratory drilling, but use of the floating vessel drilling method and the type of equipment necessary for offshore field development is becoming a near reality. Following are some basic operational techniques which have developed during several years of sub-sea drilling.

Running starting base. The floating vessel is anchored in position, and a pre-stressed concrete doughnut shaped starting base is lowered to the ocean floor with the guide cables. In the event the ocean floor has poor bearing characteristics, a mat may be used prior to setting the starting base.

A light weight bit guide then is used to guide the bit to the center or near center of the starting base. In most cases, the conductor hole is drilled in with sea water and displaced with a viscous mud prior to pulling the bit from the hole.

Running conductor pipe. Conductor casing is run in a conventional manner. The casing safety joint is added to the conductor string and spaced out so that the landing base comes to rest on the starting base (Figure 1). The casing safety joint is flanged back to additional conductor casing so that the cementing of the conductor may be accomplished in a conventional manner using an excess of cement.

After the initial setting of cement has occurred, the casing safety joint is released (Figure 2). The barrel of the casing safety joint is recovered and the desired blowout preventer hookup is added to it. The casing safety joint barrel with the blowout preventers is lowered into place at the ocean floor, using drill pipe with the blowout preventer rams closed on the pipe, which, in turn, supports the weight of this equipment. A drill nipple is then lowered from the vessel, which latches to the top of the blowout preventer hookup with a second casing safety joint.

This drill nipple has a low pressure flexible joint and a slip-joint. The slip-joint compensates for the vertical motion of the vessel and the flex-joint for horizontal motion. Slip-joints with strokes up to 22 feet are presently in use.

The drilling of surface hole may now commence. The mud returns will return to the rig through the low pressure drill nipple as in a normal drilling operation. In the event abnormal pressure is encountered during the drilling operation, the blowout preventers are used. The "cut" mud now returns to the vessel through outlets from below the blowout preventers and through flexible high pressure hoses to a choke manifold on the vessel.

After drilling the surface hole, the surface casing may or may not be run through the blowout preventer hookup in place.

Running surface casing. If the surface casing is run through the blowout preventer hookup, a sub sea well completion head will not have the flow control manifold in place. In areas where the sub-sea well completion head may be run with out the conductor casing blowout preventer hookup, the flow control manifold with its hydraulic actuating valves with mechanical closure and safety shut-in devices may be run with the surface casing (Figure 3). A protector sleeve is run in the sub-sea head to protect the receiver areas for future equipment from cement and damage in running and pulling the bit.

The sub-sea head lands inside the mandrel of the conductor casing automatic casing safety joint. This mandrel has a vent return, which is not shown, to return the mud and cement back to the vessel. This vent is located

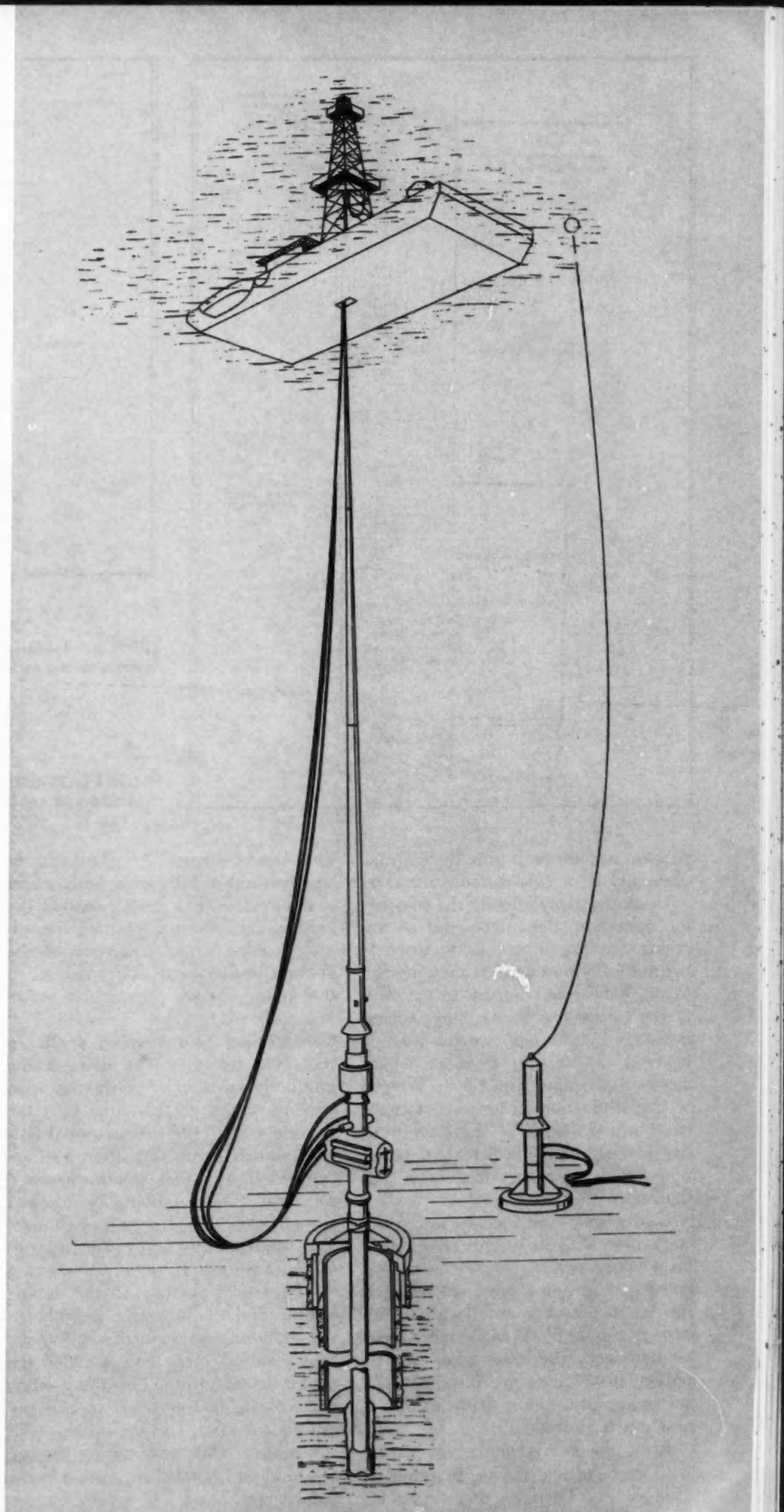
below the metal to metal seal of the conductor and surface casing.

Cementing of the surface casing is accomplished in a conventional manner. There is no restriction in the bore of the sub-sea equipment used, thus conventional cementing equipment may be used from the vessel's rig floor. After the cement is in place and the casing floating equipment is checked and found to hold, the casing safety joint is released. The barrel of this joint is unflanged from the extension casing used in cementing and the blowout preventer is flanged in place.

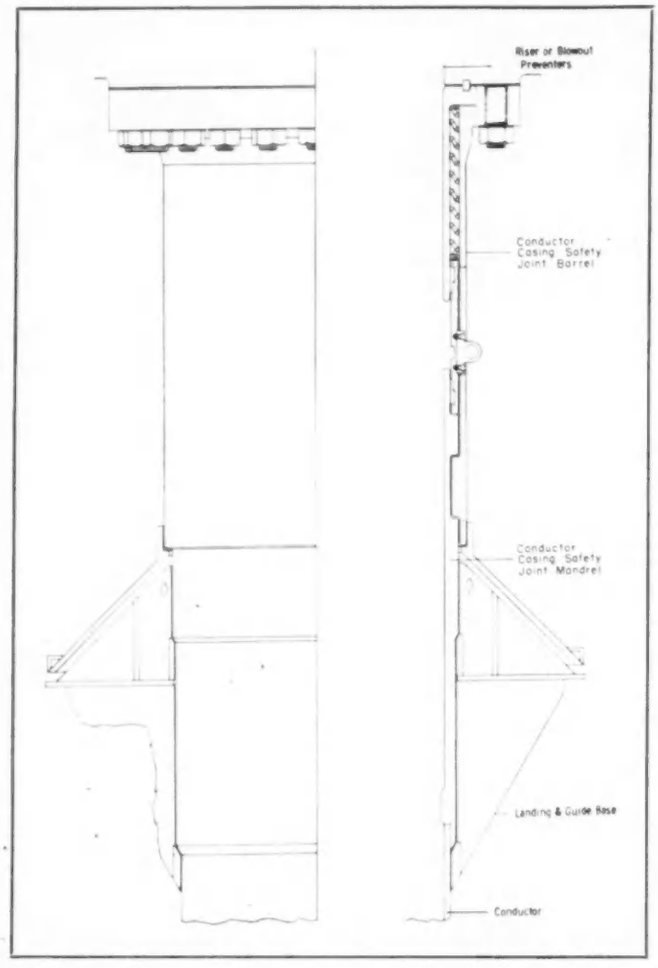
Installing blowout preventers. The blowout preventers are lowered into place on drill pipe with the rams closed on a handling sub. This drill pipe string also carries two inverted swab cups with a steel backing to test the reconnecting members of the casing safety joint. A full blowout preventer test consists of testing the blowout preventers on the rig floor prior to running and the testing of the final reconnecting joint. Anytime during future drilling operations, the blowout preventers may be tested in much the same manner. The same drill nipple used while drilling surface hole is now re-engaged to the top of the blowout preventers (Figure 4). Drilling can again be resumed.

An oil-sealed drilling bumper sub is used to compensate for vertical motion of the vessel. This bumper sub has the ability to function at high torque loads with a vertical movement of 24 inches. If the vertical motion of the vessel is greater than 24 inches, several subs are run above the drill collars. Normally the bumper sub is left out of the drillstem where fast drilling occurs and weight variations do not appreciably affect drilling time. As the drilling rate decreases, the bumper subs are added to the drillstem so that adequate bit weight may be maintained on the formation.

Running and hanging the production string. Upon the completion of drilling and the running of the logs, the protector sleeve is removed from the sub sea head. The conditioning trip prior to running the long string is made and the combination casing landing device and cutter (Figure 5) are run. This device is hung on a wash pipe below the rotary table and extends to a point above the blowout preventers. The long string of casing



Typical operation while drilling with sub-sea equipment on the ocean floor.



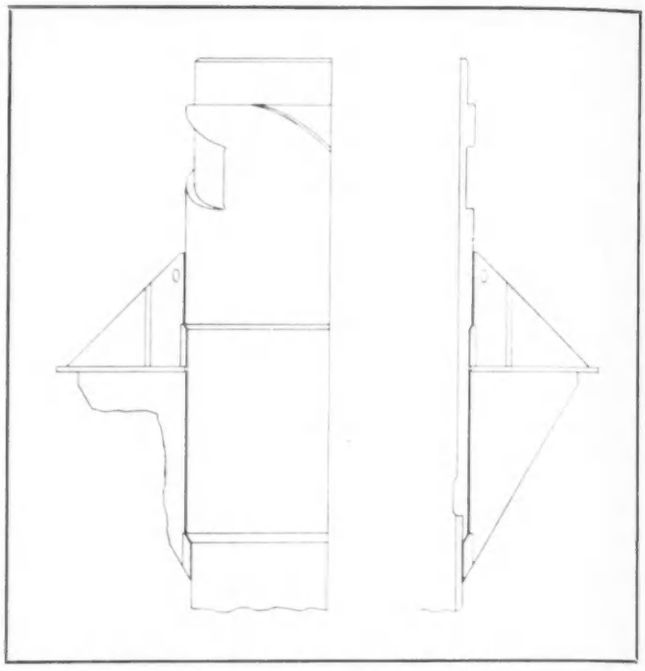


FIGURE 1—String of conductor pipe (at left) is shown connected to the casing safety joint mandrel.

FIGURE 2—Barrel portion of casing safety joint (above) is released and retrieved. Surface casing is now ready to be run.

is then run through this device and cemented in a conventional manner.

Upon the completion of the cementing operation, the inter-sleeve of the casing landing device and cutter is hydraulically pumped up allowing the casing hanger to conform to the wall of the casing due to the outer spring members. Wash pipe weight then is lowered on to this device, which moves the hanger into place. Weight of the production string is slacked off so that its weight is transmitted to the hanger. The production string now is in compression from the hanger to the vessel.

Casing tongs are used to rotate the wash pipe with its weight now riding on a thrust bearing above the casing hanger. A spring loaded sleeve feeds the knives into the outer wall of the casing (Figure 6). If the knives should be damaged, the wash pipe can be pulled, new knives are installed, and a spacing adjustment made so that a new cut is started.

After the cut is made, the casing with the cutting device is removed (Figure 7). Then an orientation bit guide unit is run into the sub-sea well head (Figure 8). This device lands on top of the casing hanger and is oriented until a spring loaded lug locks it into position, aligning the annulus outlet. The top portion of the guide is slotted so as to properly align the tubing hanger and master valve.

Completing and testing well. In the event that the long string is the production string, the production zone may be tested at this time into the floating vessel using conventional testing methods. After formation tests are completed and the well is prepared for production, tubing is run and spaced out with the tubing hanger and mechanically operative master valve (Figure 9).

The top portion of the tubing hanger and master valve assembly is the mandrel section of an automatic tubing safety joint. This is called the operating mandrel. The tubing safety joint barrel is connected to this operating mandrel, and the tubing, with the master valve and tubing hanger, is run in and landed in position in the sub-sea well head. The tubing hanger, with the master valve, lands on top of the orientation and bit guide and due to the weight of the tubing string orients itself so as to align its side outlet with the tubing outlet in the well head.

The tubing, which extends from the operating mandrel back to the vessel, is used as an access to the tubing bore. Wireline equipment and various wireline operations can be performed prior to producing the well. To produce the well, the valve is turned on by rotating the access tubing, which in turn rotates the operating mandrel and the master valves inter-sleeve.

A back pressure plug or tubing plug then is installed in a recess in the operating mandrel. The tubing bore thus is sealed above the side outlet of the master valve. The tubing safety joint is released. The blowout preventers are released from the sub-sea wellhead and pulled into the vessel. A completion cap (Figure 10) is lowered from the vessel and latches on the sub-sea wellhead at the same position that the blowout preventers were latched.

This completion cap acts as a sec-

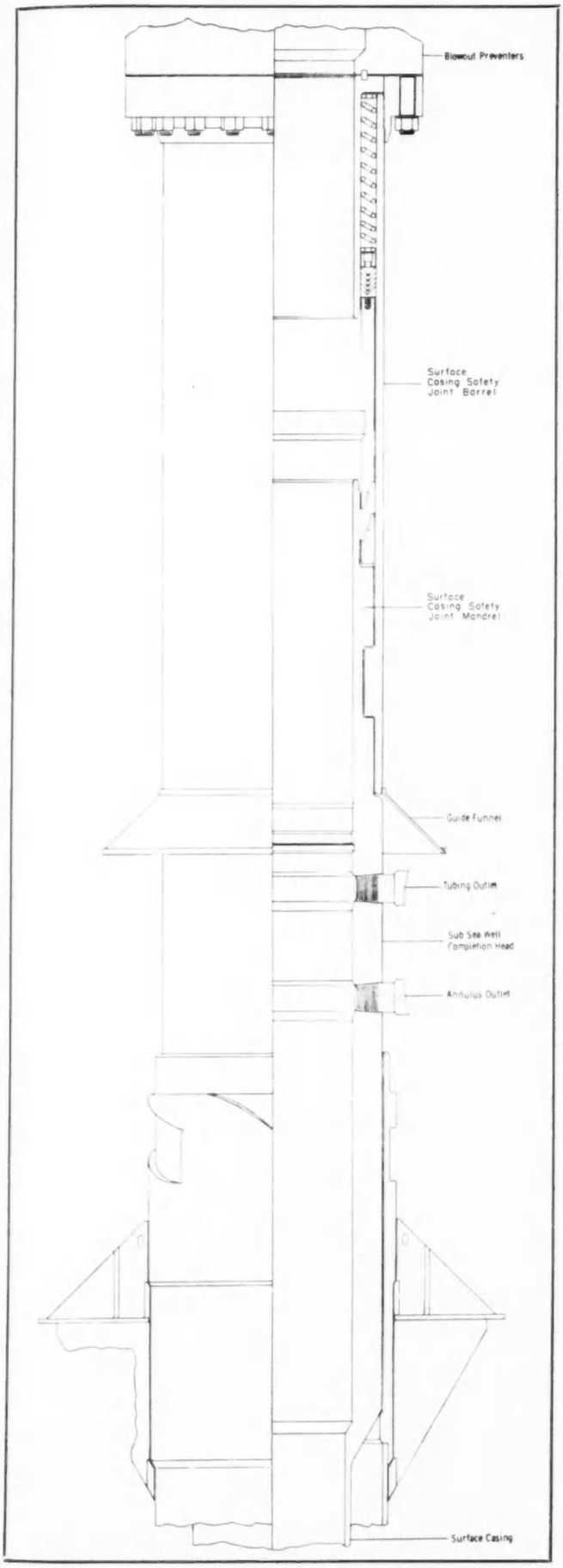


FIGURE 3—Last joint of surface casing is connected to sub-sea well completion head.

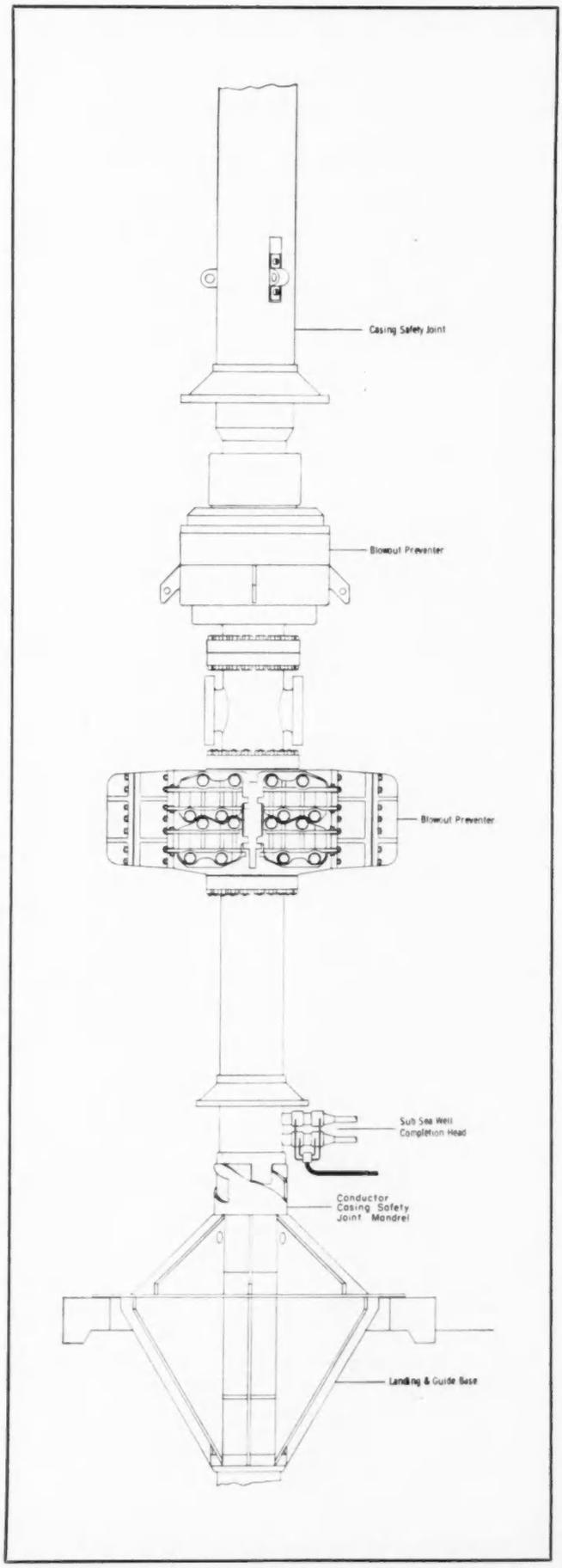


FIGURE 4—Blowout preventers are installed ready for drilling out under the surface casing.

Outer mandrel of sub-sea wellhead may be used with a special locking barrel assembly to extend the well from the ocean floor to a point above the ocean surface

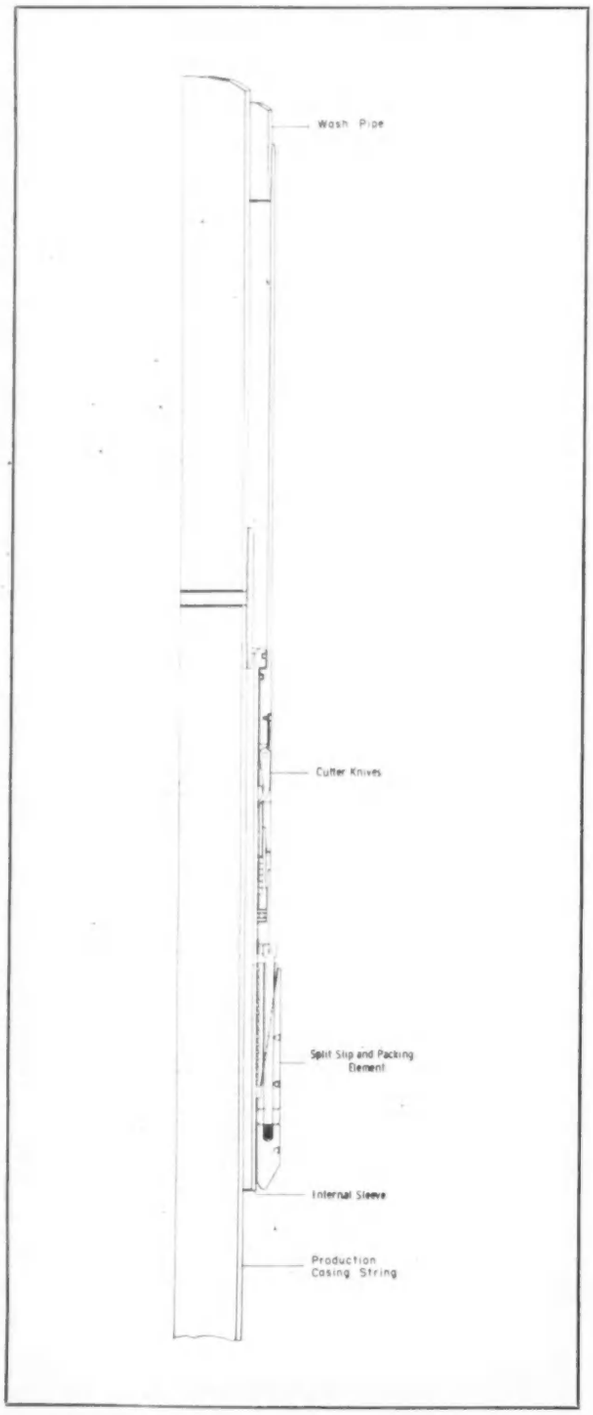


FIGURE 5—A string of wash pipe, holding split slip and packing element, is run into the riser until it stops above sub-sea well completion head.

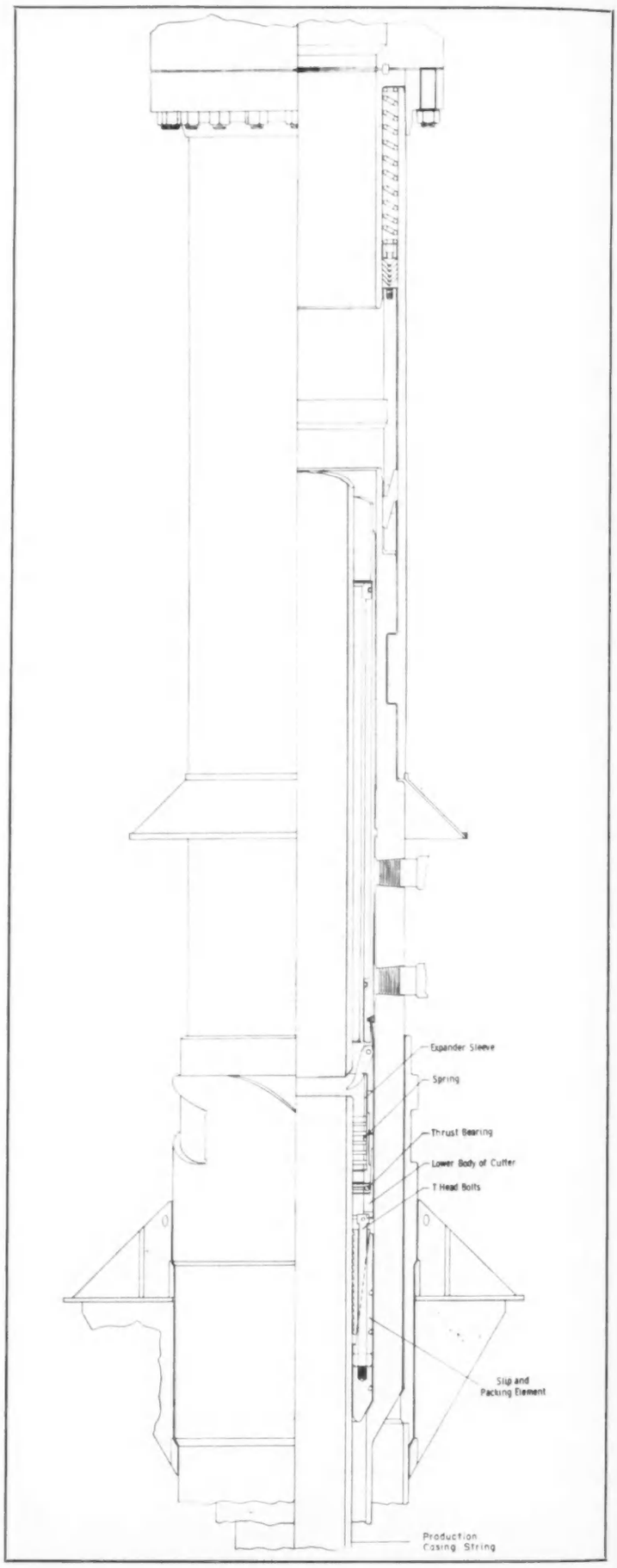


FIGURE 6—Slip and packing are shown in place and cutting knives are positioned to cut off remaining portion of production casing.

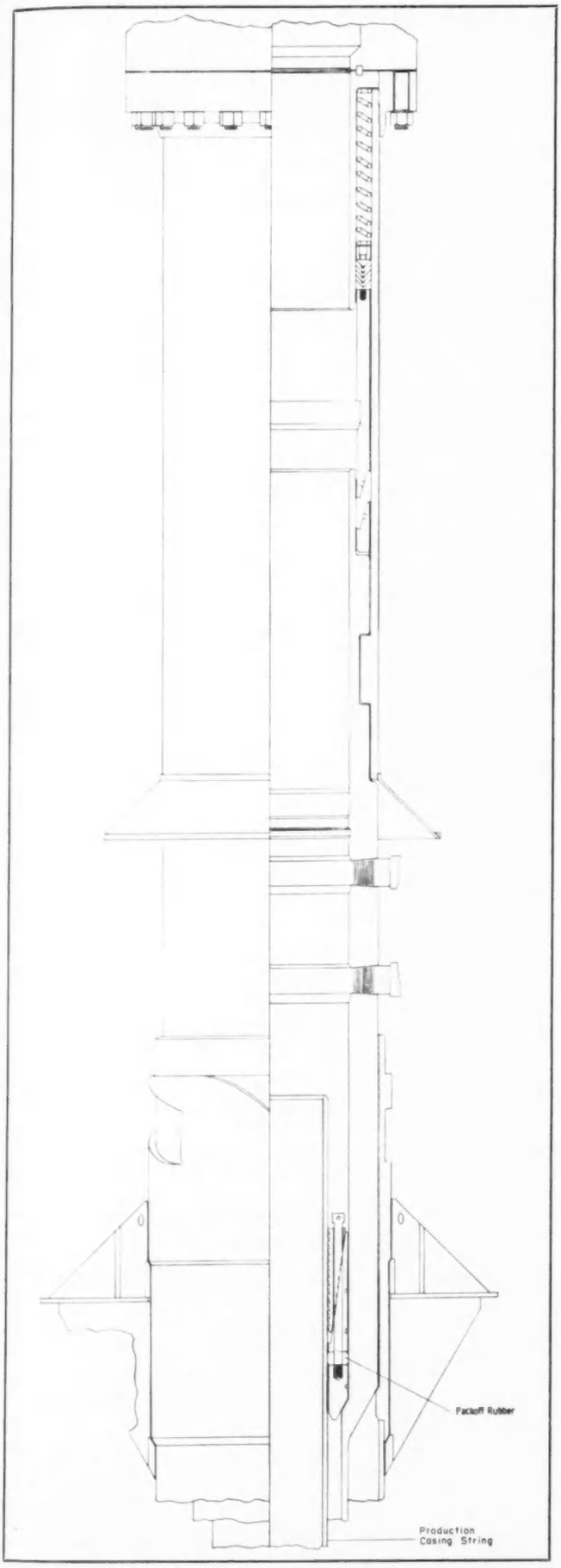


FIGURE 7—The production and wash pipe strings are retrieved from well leaving the packing element in place in wellhead.

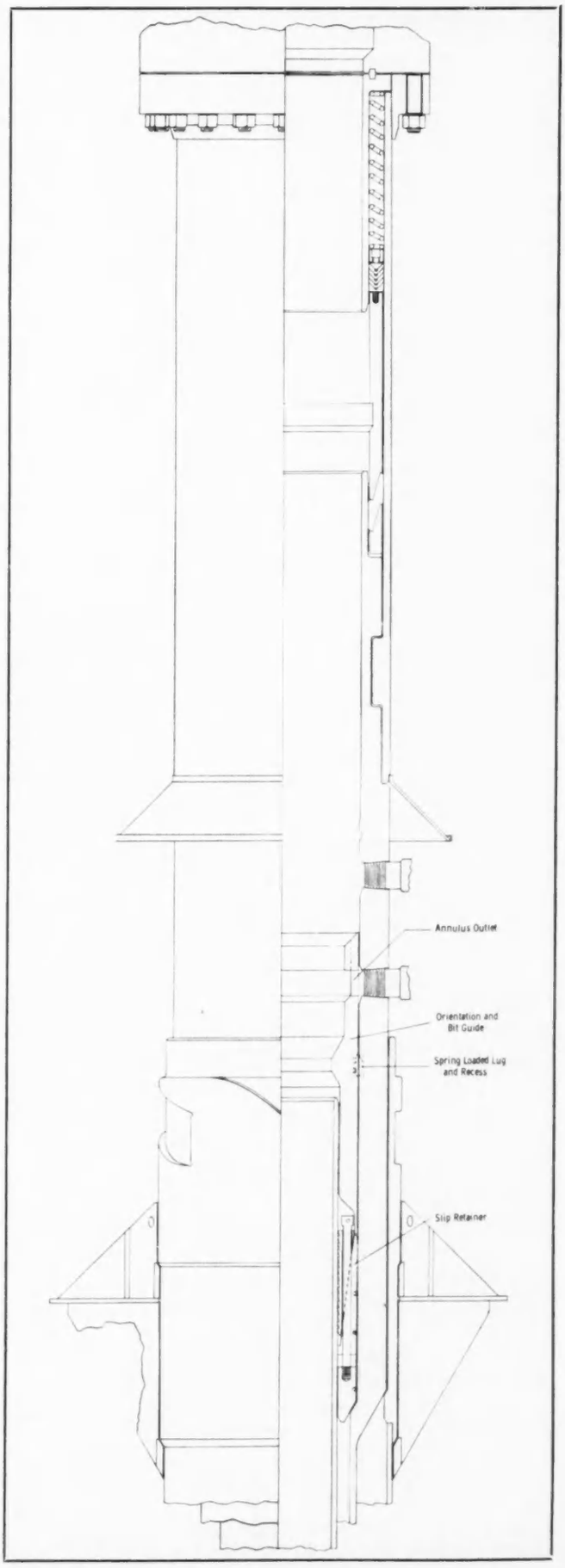


FIGURE 8—Bit guide is installed and oriented in sub-sea wellhead.

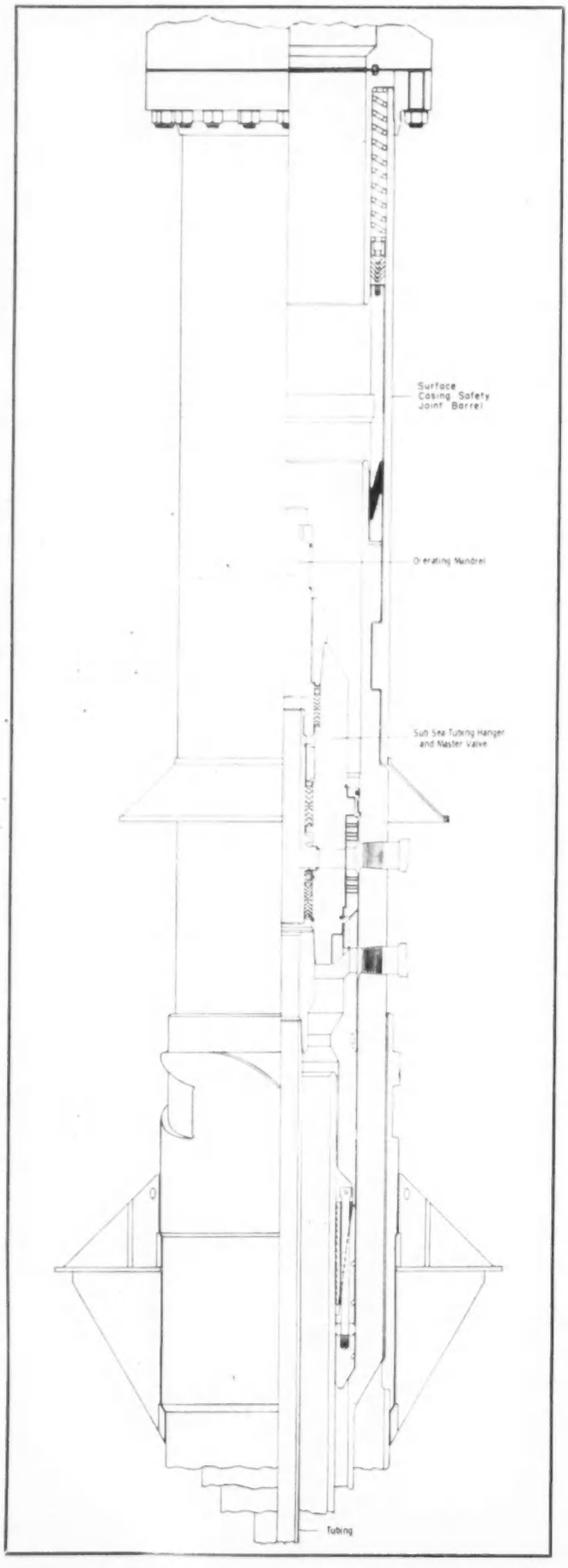


FIGURE 9—Tubing, with master valve and tubing hanger, is run in and landed in position in the wellhead.

Oil-sealed drilling bumper sub, with a movement of 24 inches, compensates for the vertical motion of the vessel

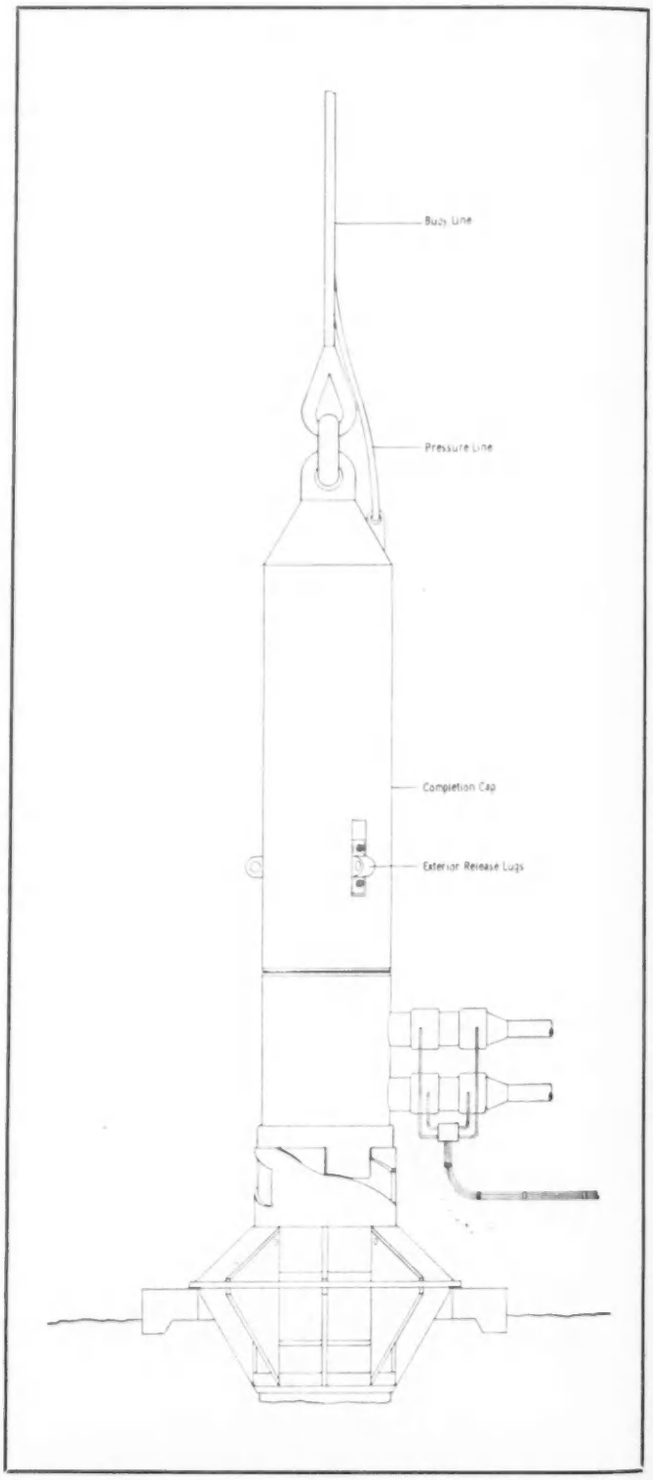


FIGURE 10—Completion cap, which serves as a secondary and final seal for the wellhead, is connected to the surface casing safety joint.

About the Author

David Guinn was graduated from The University of Texas in 1951 with a petroleum engineering degree. Following graduation he was employed by The California Company in New Orleans as drilling, production and evaluation engineer. In 1957, he joined Shaffer Tool Works as division engineer in Houston. He is a member of the AIME, API, AAODC, and a registered professional engineer.

ondary and final seal for the wellhead. It has a buoy line attached, which extends to the surface to act as a marker and guide for re-entry. There also is a pressure line attached to the buoy line, which will give an indication at the surface of leakage to the inside of the completion cap.

This completion cap is equipped with exterior release lugs, which are used to remove the cap for re-entry into the well. After the cap is removed, exposing the sub-sea wellhead's outer mandrel, blowout preventers may be re-installed and tubing pulled, if necessary. In the event it is not necessary to pull the tubing, a lubricator can be rigged up from the blowout preventer to the vessel and with an additional set of pressure controls, wireline work performed.

This outer mandrel of the sub-sea wellhead has many features. This mandrel can be used with a special locking barrel assembly to extend the well from the ocean floor to a point above the ocean surface. When the outer casing is extended, the tubing also may be extended. If this assembly is used, an additional wellhead is set above the ocean to provide access to the tubing-casing annulus.

With the possibility of major undiscovered oil deposits beneath the seas, more and more attention is expected to be focused on drilling and producing wells in deep water. It is only a matter of time until deep subsea deposits are developed and produced on the ocean floor as a routine matter. —The End

Pipe Failure in Slip Area

Continued from Page 104

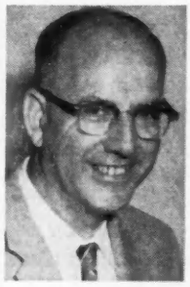
of friction, the transverse load factor varies from 1.35 to 4.37 which gives a minimum and maximum hook load to start yielding of 234,000 to 296,000 pounds, respectively. It is not likely that conditions of minimum friction would prevail in fact, transverse load factors somewhat less than 3 could be expected. Field practice supports these calculations as many wells have been drilled with this specification of pipe where hook loads in excess of 250,000 pounds were reached and no damage was experienced in the slip area.

ACKNOWLEDGMENT

All calculations undertaken by Dr. Thad Vreeland, Division of Mechanical Engineering, California Institute of Technology.

About the Authors

Reinhold



Spiri

Walter B. Reinhold was graduated from Stanford University in 1949. Following graduation he commenced working with Abegg & Reinhold Co. During 1951-53 he did graduate work in metallurgy at University of Southern California. He is a member of Nomads, AIME, API, ASME, and AAODC.

W. H. Spiri was graduated from the State College of Engineering at Winterthur, Switzerland, after serving an apprenticeship as mechanic in the field of diesel engines at Sulzer Brothers. Shortly after immigrating to the United States he entered the services of Byron Jackson Company in engineering, cost accounting and especially sales of centrifugal pumps to the oil industry. In 1938 he joined Shell Development Company stationed at San Francisco headquarters in the capacity of field engineer on new products development. With a rating of assistant marine engineer he worked with the U.S. Navy in trial work of new submarines in World War II. Since 1944 he has been chief engineer of Abegg & Reinhold Company, Los Angeles. He has a degree from I.C.S. in business administration and sales and is a registered mechanical engineer in the state of California. He is an active member of the American Petroleum Institute, Division of Production.

Penetration Rate Increases

Continued from Page 107

then, that if there was no change in pitch resulting from this change in collar size, a vertical distance of (0.79 x 2) 1.58 feet would be drilled in the same time required to drill 1 foot with the smaller collars. The drilling rate is improved more than 50 percent.

This discussion has been basically qualitative because of a lack of quantitative data available. However, it does point to possibilities for a need in further quantitative work on all fundamental forces mentioned.

Qualitatively, it suggests that to provide a large enough hole to set large diameter casing in areas where the rate of penetration is high, larger drill collars should be considered before larger bits. In areas where the rate of penetration is low, improved stabilization of the bit is indicated if maximum effective penetration is to be obtained.

Questions must be answered. The following questions must be answered before the optimum drilling hook up can be designed.

- What is the effect of rotary speed on the horizontal forces at the bit?
- What is the effect of weight on the bit on the horizontal forces created by rotation?
- What is the effect on the above forces created by a change in clearance between the bit and drill collar?
- Does the competency or strength of the formation have any bearing on the ability of the bit to guide itself without help from the drill collars?
- Does the competency or strength of the formation affect the time required for the center of the bit to describe a circle or only the diameter of the circle or both?

Answers to these questions presently should be approached from a laboratory basis because of a minimum knowledge of field data evaluation. However, from the limited field experience presently known, it is believed that if the present drilling and logging records were re-examined a more optimum weight, rotary speed and drill collar bit size relationship would be obtained and would ultimately result in a marked improvement in the present drilling operations. —The End

New developments in high

Special testing procedures and equipment are needed when handling elevated temperature mud

By Jack C. Cowan
Laboratory Engineer
Baroid Division, National
Lead Co., Houston

CURRENT DRILLING OPERATIONS are exploring formations at depths of 20,000 feet to 25,000 feet with temperatures ranging above 400° F. As drilling depths increase, temperatures above this figure may be expected.

Various high temperature drilling fluids and additives have been developed simultaneously with deeper drilling, since conventional drilling fluids are limited in use at high temperatures (above 400° F). Conventional mud limitations usually are the result of one or more of the following factors:

- A thermal or biological breakdown of one or more drilling fluid components.
- A decrease in the viscosity of the liquid phase with increasing temperature.
- A combination of materials that solidify (i.e., lose fluidity) in the presence of high temperature, or
- A significant decrease in the solubility of certain electrolytes that permit increased hydration of shale solids.

These environmental alterations can result in an undesirable increase in rheological and filter loss properties, thus increasing the difficulties of deep-hole drilling. Stuck pipe or casing, poor logging tool runs, blowouts due to swabbing, fishing expenses and down-time to condition mud may be expected.

To overcome these limitations, new and old drilling fluid additives have been tested for use at well temperatures of 300 to 450° F. Performance evaluations of these formulations requires special procedures and testing equipment.

Lignite-sodium-surfactant mud. This type mud, proposed for high temperature service, exhibits low filtrate loss and retains good rheological properties at 450° F. It is not a highly complex drilling fluid and maintenance and control of properties should be no more difficult than with conventional muds. Filtration data was obtained while mud samples were subjected to temperatures as high as 450° F. This data is thought to be more indicative of actual conditions at these temperatures than relative data obtained by heating samples then cooling back to room temperature before testing.

Lignite-sodium-surfactant mud is not intended to replace conventional drilling fluids. Furthermore, it is realized that the proposed formulation will not solve all high temperature mud problems. It is believed, however, that this relatively simple and inex-

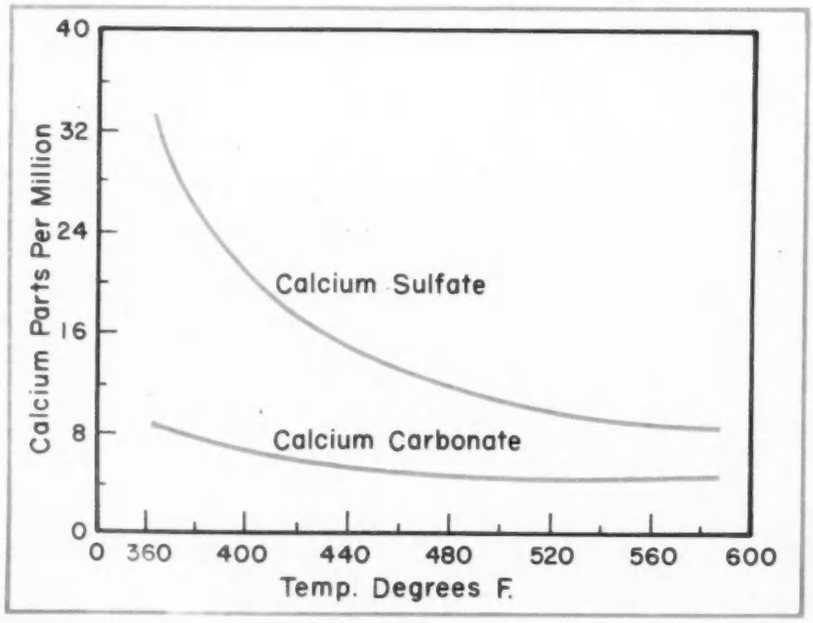


FIGURE 1—The solubility of calcium for calcium sulfate and calcium carbonate decreases with an increase in temperature.

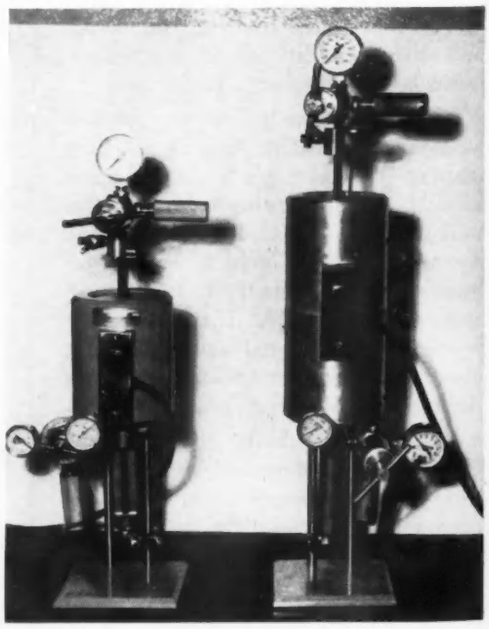


FIGURE 2—New type high pressure-high temperature filter presses were designed for lab use.

temperature drilling fluids

pensive mud will further reduce temperature limitations of drilling fluids.

Importance of minimum filtration at elevated temperatures. Filtration of drilling fluids must be controlled at elevated temperatures. For many years, the most important single property of a drilling fluid was its ability to form a thin and impervious cake on the wall of the bore hole. This property becomes even more significant when weighted drilling fluids are subjected to temperatures above 300° F. Therefore, it is imperative that the filter loss additive selected for a high temperature drilling fluid formulation, be effective at the temperatures encountered.

The primary limitation of conventional drilling mud subjected to high temperatures is the significant increase in filter loss. This generally is caused by changes in the organic colloid being used for filter loss control. These changes are associated with high temperatures and are due partly to oxidation, polymerization or depolymerization, hydration and other reactions not completely understood at this time. Starch, when used as a filter loss controlling agent in lime muds, broke down when mud was aged at temperatures of 300° F. Dextrins and other products were formed that were less effective than starch. In certain surfactant muds, synthetic colloids—such as carboxymethyl cellulose and acrylic polymers—lose effectiveness above temperatures of 400° F. Discrepancies have been observed in high temperature filtration data of muds containing acrylic polymers. High filter losses occurred when a mud containing a polyacrylate was filtered at 400° F. Yet, an identical sample, when cooled to room temperature and filtered, exhibited relatively low filter loss.

Laboratory and field observations indicate that another type of breakdown can occur in organic filter loss additives such as starch and cellulose derivatives. These changes usually occur at moderate temperatures and generally are attributed to the action of micro-organisms and enzymes. Many methods and additives have been used to prevent bacterial spoilage of organic colloids. Some problems of extreme filter losses at elevated temperatures may be related to bacterial or enzymatic effects, although high temperatures prevents growth of most bacteria and probably is helpful in combatting filtration control.

Another factor affecting filtration properties of fluids at high temperatures is the decrease in the viscosity of water with increasing temperature. Filter loss is inversely proportional to the one-half power of the filtrate viscosity, and may be calculated from the temperature if other conditions remain unaltered. Table 1 shows the relationship of filtrate viscosity and the square root of filtrate viscosity with increasing temperature. Other things remaining equal, a mud should lose $\sqrt{1.005/0.2838} = 1.88$ times as much water at 100° C as at 20° C.

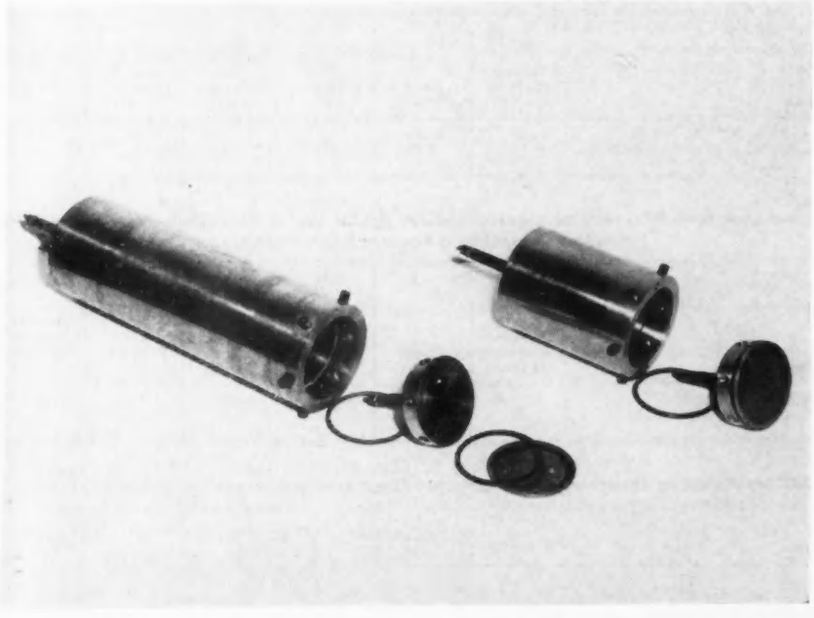


FIGURE 3—A comparison of the modified filter cell and the conventional filter cell body is shown above.

FIGURE 4—Here are modified and conventional high temperature static aging cells.

TABLE 1—The Relationship of Filtrate Viscosity and the Square Root of Filtrate Viscosity with Increase in Temperature

°C	°F	η, Centipoise	$\sqrt{\eta}$
0	32	1.792	1.339
10	50	1.308	1.144
20	68	1.005	1.002
30	86	0.801	0.895
40	104	0.656	0.810
60	140	0.469	0.685
80	176	0.3565	0.597
100	212	0.2838	0.523
120	248	0.232	0.482
140	284	0.196	0.444
160	321	0.174	0.417

TABLE 2—Use of Lignite, Caustic Soda, and Soda Ash for Filtration Control In a Low-Sodium Surfactant Field Mud

Properties	Before Treatment	After Lignite-Alkali Treatment
Weight, ppg	17.5	17.5
Viscosity, cp	86	82
Initial gel, g	20	0
10-min gel, g	50	27
pH	8.0	7.3
Filtrate, API, ml	12.5	1.4
Plastic viscosity, cp	31	49
Yield Point, lb/100 sq ft	43	19
Filtrate, 400° F, 500 psi, ml/30 min	140	19
Oil, % by volume	6	..
Solids, % by volume	34	..
Water, % by volume	60	..

Also, filter loss multiplied by the square root of filtrate viscosity gives an index to the filter independent of filtrate viscosity. Thus, the effect of temperature on the mud itself can be determined.

Temperature flocculation of solids is another important factor directly related to increasing filtration with increasing temperature. The average permeability of filter cakes increased with increasing temperature. The increase in permeability was similar to that which might be expected under flocculating conditions, and, therefore it was assumed a temperature flocculating mechanism was responsible. In a drilling mud, the temperature might cause a hydrating effect on drilled solids in the absence of sufficient electrolyte to maintain an aggregating environment. Such high-temperature hydration might provide lower filtration rates if high-temperature flocculation could be avoided.

Some muds exhibit low filtration rates at high temperature but become solid or semi-solid when subjected to elevated temperature without agitation for a period of time. A lime mud is a typical example of this phenomenon. Lime and caustic soda react with the silica and clay components in a drilling fluid to form poorly crystalline silicates that function as cementing agents at temperatures approaching 300° F. Also low alkalinity lime-treated muds were less susceptible to gelation at high temperatures. In high temperature drilling fluids, the more nearly neutral in pH a mud becomes, the less likely are the chances of forming cementation products. Cementation reactions can be avoided by allowing a mud system to stabilize at the natural pH range for montmorillonite of 7.0 to 9.0.

Hydration of clay solids caused by the decrease in solubility of certain electrolytes with increasing temperature also may contribute to high temperature gelation. This condition may exist if the ions of calcium sulfate or calcium carbonate are present. Figure 1 is a graphic example of the decrease in calcium ion from calcium carbonate and calcium sulfate with increasing temperature. A similar decrease in solubility occurs in the calcium ion derived from calcium hydroxide. In a high temperature system, dependent upon sufficient electrolyte concentration to prevent hydration and dispersion of solids, it is necessary to select ions that either maintain or increase their solubility with increasing temperature and that are compatible with other ions that are a necessary part of the system.

Surfactant muds were designed primarily to cope with the problems of high temperature. These muds, however, are limited by the temperature tolerance of the filter loss additives. These muds have, for the most part, utilized cellulose and polyacrylate derivatives for filtration control.

Certain lignites, when reacted with sodium alkalies, have proved to be effective filtration control agents in surfactant muds.

Laboratory investigation. Special surfactant systems can be used effectively along with sufficient soluble salts to maintain drilled shale solids in an aggregated state.

Early experimental work with surfactant systems indicated that the usual thinners or dispersants used to control flow properties should not be used in surfactant muds. This was based on the premise that such treatment would cause shale particles to disperse and hydrate rather than remain as the less-hydrated aggregates that could be maintained if only soluble inorganic salts were present. As a result of this treating limitation, high viscosities, gel strengths and yield points have been characteristic of high-density surfactant muds. Additions of the usual sodium carboxymethyl cellulose or polyacrylate derivatives further aggravate these undesirable flow and gel characteristics. It has been necessary to resort to centrifugation and water dilution to control flow and gel properties of such muds.

Current field practice includes use of flow control chemical agents in surfactant muds. Sodium carboxymethyl cellulose is used in calcium surfactant or gypsum muds to control

TABLE 3—Cost and Efficiency of Lignite-Sodium Alkali and Sodium Carboxymethyl Cellulose for Filtration Control in a Sodium Surfactant Mud

Material	Concentration (lb/bbl)	Cost ($/bbl)	API Filtrate (ml)	Aged 450° F API Filtrate (ml)	Filtrate 350° F 500 psi (ml)	Filtrate 450° F 500 psi (ml)
Mined Lignite-Sodium Alkali	15	$1.50	1.8	12.0	24	85
Sodium Carboxy-methyl Cellulose	3	2.70	4.6	37	No shut off	No shut off

TABLE 4—Cost and Efficiency of Lignite-Sodium Alkali and a Polyacrylate Derivative for Filtration Control in a Sodium Surfactant Mud

Material	Concentration (lb/bbl)	Cost ($/bbl)	API Filtrate (ml)	Rolled 16 hr at 150° F API Filtrate (ml)	Aged 16 hr at 400° F API Filtrate (ml)	Filtrate, 400° F 500 psi (ml)
Polyacrylate Derivative	1.5	$1.05	6.8	4.0	5.9	80
Mined Lignite-Sodium Alkali	10	1.05	1.2	0.8	2.2	24

TABLE 5—Relative Effectiveness of Organic Filter Loss Additives in Water Solutions

Materials	Concentration (lb/bbl)	API Filtrate (ml)	pH	Viscosity (cp)
Starch	15	No shut off	7.2	9
Sodium Carboxy-methyl Cellulose	15	16	8.7	541
Polyacrylate	15	No shut off	9.1	64
Lignosulfonate	15	No shut off	9.2	4
Mined Lignite-Sodium Alkali	15	7.0	9.0	4

TABLE 6—High Temperature Properties of a Gypsum Ferrochrome Lignosulfonate Mud before and after Conversion to a Lignite Sodium Surfactant Mud

Properties	Gypsum Ferrochrome Lignosulfonate Mud Before Conversion	Lignite Sodium Surfactant Mud After Conversion
Weight, ppg	16.0	16.0
Viscosity, cp	42	54
Initial gel, g	0	0
10-min gel, g	0	0
pH	9.1	9.5
Filtrate, API, ml	5.2	0.0
Filtrate, 350° F, ml/30 min.	35	6.5
Filtrate, 400° F, ml/30 min.	46	8.0
Filtrate, 450° F, ml/30 min.	78	10.0

Materials added for Conversion:
8 lb/bbl water soluble oxyethylated phenol, 2.4 lb/bbl sodium chloride, 3 lb/bbl sodium carbonate, 10 lb/bbl lignite, and 0.5 lb/bbl sodium hydroxide.

filter loss up to temperatures of 325° F.-375° F. At higher temperatures, some muds have been converted to sodium surfactants so that the more thermally stable polyacrylate derivatives could be used for filtration control. Conversion to sodium is necessary because acrylic polymers are sensitive to calcium ion concentrations above 100 parts per million. The value of alkalilignite in a high-density surfactant mud is shown in Table 2. This sodium surfactant mud sample utilized sodium carboxymethyl cellulose and a polyacrylate derivative. It was obtained from a 17,000-foot well in Plaquemines Parish, Louisiana.

The sample had the following properties: 15 pounds of lignite, 1.3 pounds of caustic soda, and 1 pound of soda ash per barrel of mud. Viscosity, gel strength and yield point were reduced significantly. At the same time, a low pH of 7.3 (80°F) was maintained while reducing the filtrate at 400° F from 140-ml/30 min. to 19-ml/30 minutes.

An unusual feature of this mud composition is the concentration of lignite used to obtain the low filter loss at high temperature. Costwise, the amount involved, including accessory chemicals, is less than when conventional synthetic polymers are used (see Tables 3 and 4). Another unique property of this alkaline-lignite material is its ability to function as a filter loss reducer independent of added or drilled solids. Table 5 shows the relative effectiveness of various organic filter loss additives in water solutions. It should be noted that even though the sodium carboxymethyl cellulose gave a low filter loss, the viscosity at the concentration necessary would be impractical for field usage.

Currently, there is a wide use of various types of gypsum muds utilizing ferrochrome lignosulfonates and, perhaps, sodium carboxymethyl cellulose at temperatures up to 375° F. Table 6 shows the high temperature properties of a gypsum mud before and after conversion to a lignite-sodium surfactant. Recommended steps necessary for such a conversion are as follows:

- Eliminate alkali additions being used to control pH in the gypsum mud and continue additions of ferrochrome lignosulfonate to reduce pH to 7-8.
- Add water soluble oxyethylated phenol surfactant to obtain a slight excess (usually 2 to 6 pounds per barrels, depending upon solids present).
- Add sodium chloride to raise the salt concentration to 15,000 to 20,000 ppm.
- Add soda ash for removal of total hardness.
- Add 5 to 15 pounds per barrel lignite, 0.25 to 1.0 pound per barrel caustic soda, and soda ash to raise pH to between 8.5 to 9.5.

The solids content should be reduced by centrifugation or water dilution. It also is desirable to have the mud contain 8 to 10 percent by volume of oil prior to the addition of surfactant.

Laboratory data indicate that gypsum muds converted to a lignite-sodium-surfactant mud by the steps outlined above do not go through transition "breakovers." Mud properties generally remain the same throughout the conversion. Muds, other than a gypsum mud, could be converted in a similar manner. The medium pH and the tolerance for salt exhibited by the gypsum mud treated with ferrochrome lignosulfonate, however, make it a particularly convenient system for this type of conversion.

Aging tests over periods of 16, 64 and 352 hours indicate lignite-sodium-surfactant muds are quite stable over long periods of time. Table 7 shows the static aging properies of a lignite-sodium-surfactant mud prepared with 0.56 barrel of water, 10 pounds of lignite, 1.2 pounds of caustic soda, 13 pounds bentonite, 3 pounds of salt, 6 pounds oxyethylated phenol surfactant, 0.06 barrels of diesel fuel, 473 pounds of weight material and 1.5 pounds of soda ash.

Testing equipment and procedures. Conventional testing equipment was modified to obtain reliable data at temperatures of 350 to 450° F. The high pressure-high temperature filter press (Figure 2) was modified and the cell body volume increased from approximately 140 ml to 490 ml. Figure 3 shows the conventional cell body and the larger modified cell body. This increase in working volume was necessary to maintain a sufficient volume of mud sample and to accomo-

Continued on Page 127

TABLE 7—Static Aging Properties of a Lignite Sodium Surfactant Mud

Properties	Initial	Rolled 16 hr. at 150° F	Aged 16 hr. at 400° F	Aged 64 hr. at 400° F	Aged 352 hr. at 400° F
Weight, ppg	16.5	16.5	16.5	16.5	16.5
Viscosity, cp	64	51	104	86	82
Initial gel, g	0	0	0	0	0
10-min gel, g	10	0	50	100	70
pH	9.4	8.9	8.1	8.0	8.0
Filtrate, API, ml	1.6	1.7	2.6	3.3	8.4
Plastic viscosity, cp	43	36	....	....	....
Yield Point, lb/100 sq ft	7	1	....	....	....
Condition of Mud	....	....	Gel	Gel	Gel
Shear Strength, lb/100 sq ft	....	....	125	200	320

TABLE 8—Effect of Pressurized and Unpressurized Static Aging Cells on Mud Properties

Properties	Gypsum Ferrochrome Lignosulfonate Mud Aged 16 hr at 350° F		Lignite-Sodium Surfactant Mud Aged 16 hr at 350° F	
	(Unpressurized)	(Pressurized)	(Unpressurized)	(Pressurized)
Weight, ppg	16.0	16.0	16.0	16.0
Viscosity, cp	51	46	82	60
Initial gel, g	0	0	0	0
10-min gel, g	20	20	40	40
pH	7.8	8.6	8.3	8.9
Filtrate, API, ml	13	14	1.2	0.1
Plastic viscosity, cp	23	25	44	37
Yield Point, lb/100 sq ft	15	4	27	20
Condition of Mud	Gel	Gel	Gel	Gel
Shear Strength, lb/100 sq ft	250	200	200	100

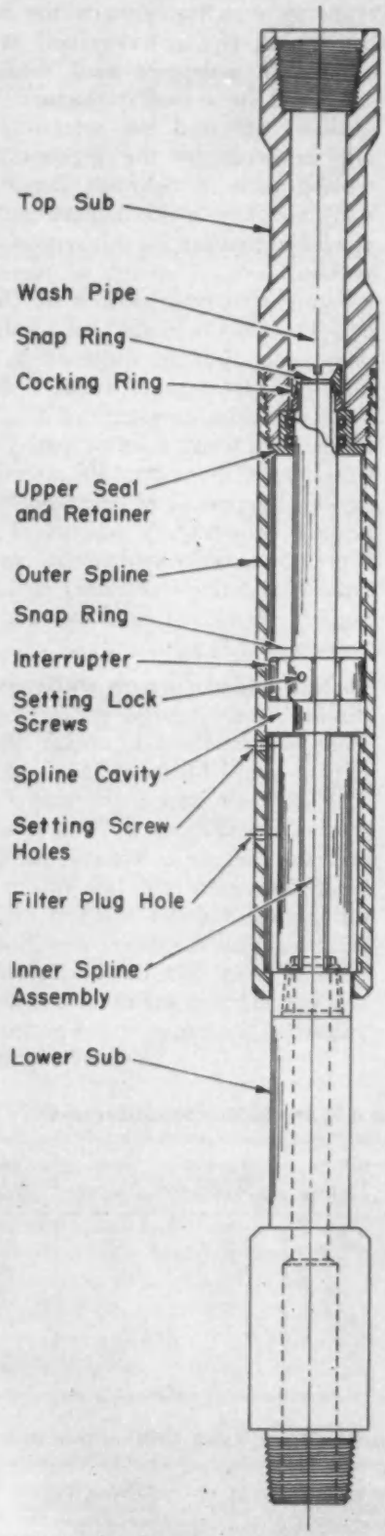


FIGURE 1—Bottom-hole orienting sub is composed of four sub assemblies. All are shown assembled in the extended position.

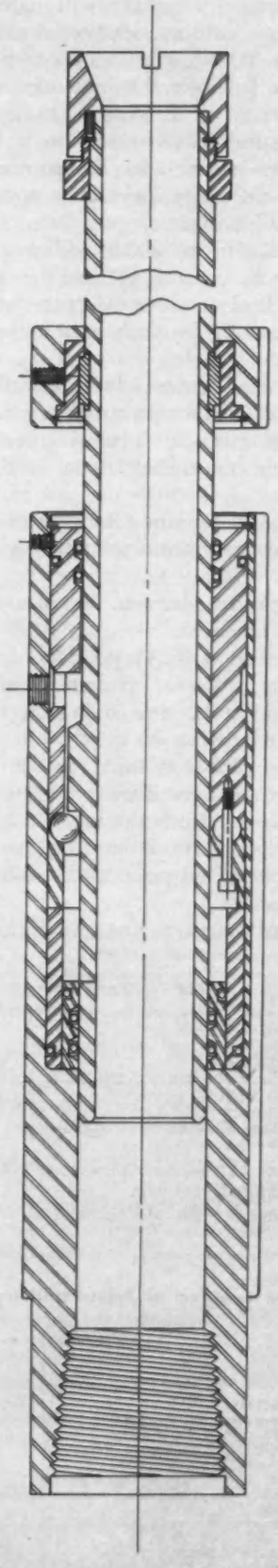


FIGURE 2—The top sub closes the outer spline barrel and connects drill pipe to the sub assembly as shown at right.

New method for . . .

Orienting

This tool eliminates mud conditioning time, reduces stuck pipe possibilities, eliminates use of wire line instruments, and enables setting the whipstock at the bottom of the hole

By Darrell L. Sims
Chief Engineer
Reagan Forge and Engineering Co.
San Pedro, Calif.

A NEW ORIENTING sub has been developed which transmits bottom-hole information through the drill string to the surface.

This device, which correctly places a whipstock, has been field tested successfully in holes where the angle of deviation ranged from 3 to 39 degrees. Several whipstocks have been set below 12,000 feet with an average orientation time of 28 minutes.

This new tool:

- Eliminates mud conditioning time.
- Orients and sets whipstock upon reaching bottom and not up the hole.
- Keeps drill pipe moving, avoiding possible stuck pipe.
- Obtains a mechanical and positive indication.

In designing the new bottom-hole orienting sub, the drill string was shortened by a gravity actuated latch. A ball rolling in an oil-filled chamber was used as the tripping element. The trip was so arranged (the rotation of an interrupter) so the collapsing weight of the pipe was not applied directly to the ball. The ball only cams the interrupter and wash pipe. A high degree of accuracy is achieved by rolling the ball from the high side of the hole and stopping and using the ball before it reaches the low side. This eliminates

bottom-hole deflection tools

errors from early or late moving of the ball at low angles.

Component parts of orienting sub. The assembled sub (Figure 1) is composed of four sub assemblies. The top sub (Figure 2) closes the outer spline barrel and connects to the drill pipe. It is sufficiently long to protect the wash pipe in the up position and is shaped to fit the elevators. The lower sub connects the inner spline to the drill pipe, and has a shoulder that stops the collapsing action by taking the weight of the drill string.

The outer spline barrel transmits the torque to the inner spline in both

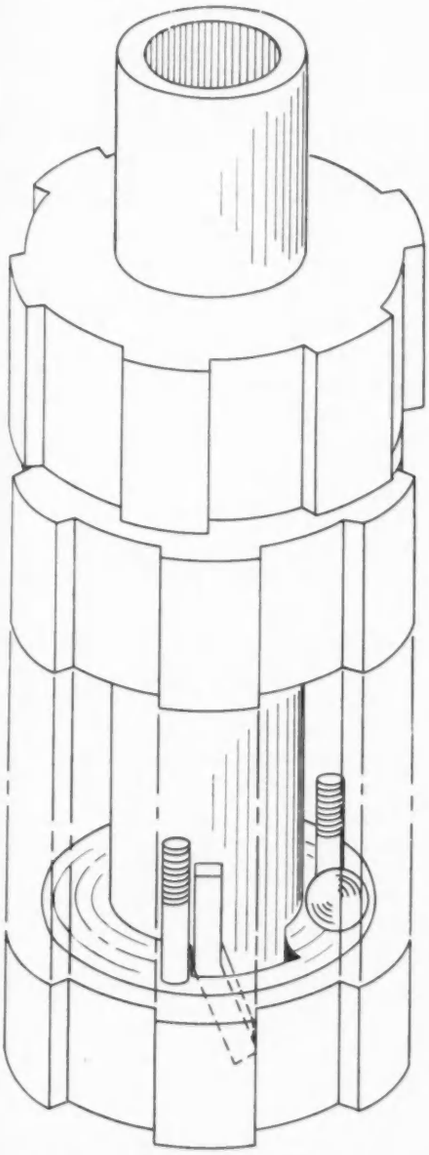


FIGURE 3—The wash pipe has a finger shaped cam on its outer surface.

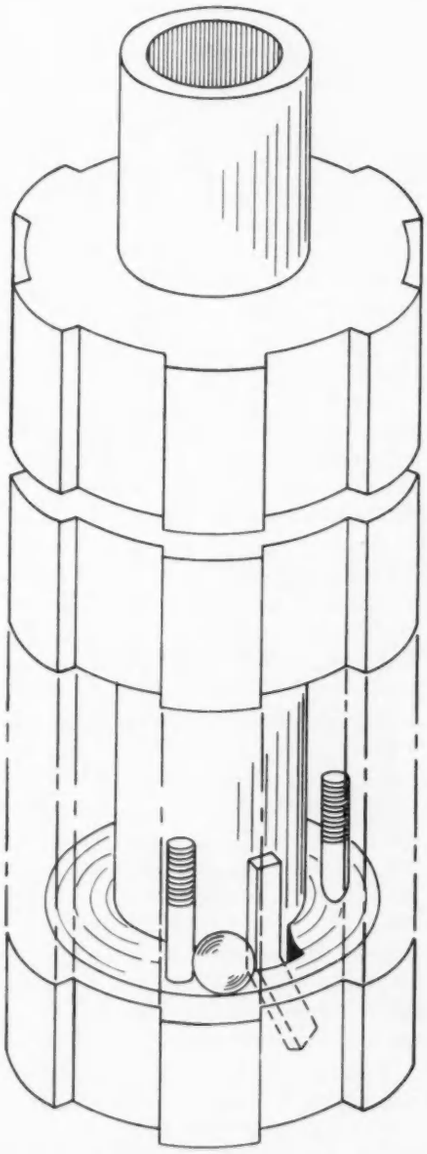


FIGURE 4—When the ball is against the stop pin as shown above, the cam is free to move up and down and will force the wash pipe to rotate 15 degrees.

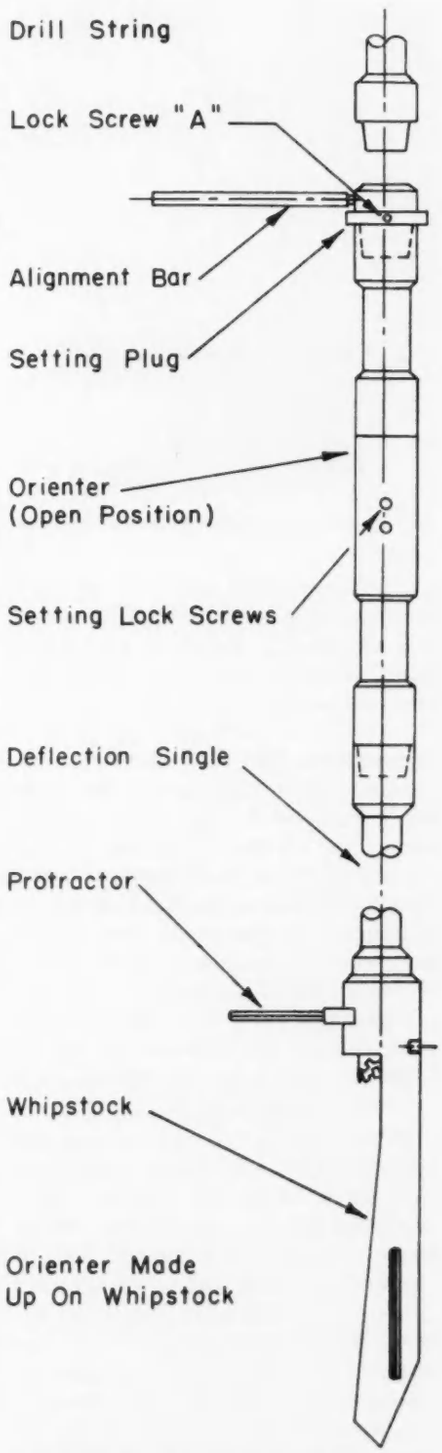


FIGURE 5—This is the orienting sub made up on the whipstock.

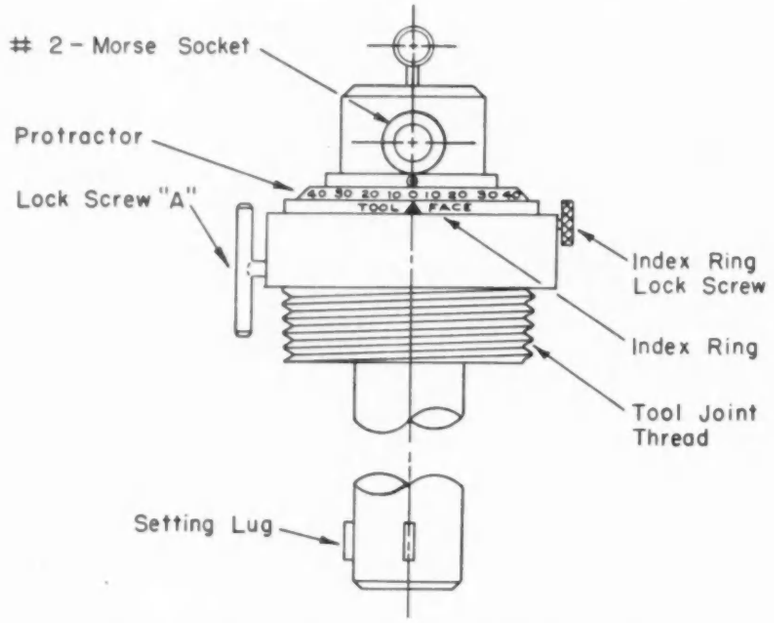


FIGURE 6—The setting plug fits into the top of the wash pipe. The lug on the setting pipe must be in the slot in the top of the wash pipe.

the open and closed positions and contains a pocket in which the interrupter is free to rotate (15 degrees).

The inner spline and wash pipe assembly complete the unit. It contains the oil filled race, ball and cam that rotate the interrupter and allow the sub to close.

Operation. In the assembled extended position (Figure 1), the wash pipe is up while the interrupter is at the top of the pocket and turned 15 degrees to be misaligned with the outer spline above it. The interrupter is fastened to the wash pipe with a set screw. The wash pipe passes through the ball chamber and has on its outer surface a finger shaped cam (Figure 3). This key is free to move up and down through a notch cut in the ball race.

When the ball is not against the stop pin, the cam moves straight up and down. When the ball is against the stop pin, the cam still is free to move up and down, but is forced to rotate the wash pipe 15 degrees (Figure 4). This also rotates the interrupter into alignment with the upper spline. Thus, if weight is applied to the top sub with the ball not against the pin (Figure 3), the upper spline picks up the interrupter and pushes it down to the top of the inner spline. As the interrupter is 15 degrees out of alignment, collapsing is halted. When weight is applied with the ball against the pin, the upper spline picks up the interrupter and pushes it down. The cam reaches the ball and rotates the wash pipe (and interrupter) 15 degrees before the interrupter reaches the top of the inner spline.

The inner spline and interrupter are now aligned and will continue to collapse until the lower sub reaches the lower outer spline barrel. The ball is retained in a 120-degree section of the race by the stop pin. The index pin (Figures 3 and 4), ball race and interrupter may then be turned in the inner spline by turning the wash pipe. The wash pipe has a tapered slot in the upper end exactly in line with the index pin. After turning, a set screw locks the ball race (and index pin) to the inner spline.

The zero point of orientation occurs when the ball rolls from the index pin to the stop pin. At this point, the index pin is aligned with the high side (or direction) of the hole. The ball is retained by the stop pin for an additional 60 degrees of rotation. This allows locating the trip point on bottom without excessive probing.

The tool will orient anything on which weight can be placed. At present, it has been used to orient whipstocks for directional drilling; consequently, the setting of a whipstock will be used to explain the operation of the tool on the surface.

WHIPSTOCK OPERATION

The whipstock is made up on the deflection single of drill pipe and the shear pin inserted. The whipstock and a single are lowered into the hole, and the face side of the whipstock is marked on the top tool joint. The bottom-hole orientation (BHO) sub is made up on the single, making sure all joints are tight. The setting plug is screwed into the top tool joint of the BHO sub with the sub in the open position with care being taken to align the tapered lug with the tapered slot in the wash pipe. The alignment bar (Figure 5) is inserted in the taper pin hole (Figure 6) in the setting plug (Figure 5). The two setting screws are loosened (Figure 5), and the alignment bar approximately aligned with the whipstock face mark on the tool joint. The bar is safely tied and the two setting screws are tightened.

The whipstock is picked up until the face is half way through the rotary table. The protractor (Figure 7) is placed on the whipstock face and the hair line aligned with the alignment bar. The angle between whipstock and alignment bar is read and recorded. The orienting sub is lowered to the table, and the index ring (Figure 6) of the setting plug is turned until it is aligned with the whipstock face (the correction angle read on the protractor). The setting screws are loosened and the alignment bar (zero on the protractor ring) turned until the correct setting (for example, 120 degrees right) is in line with the "tool face" line on

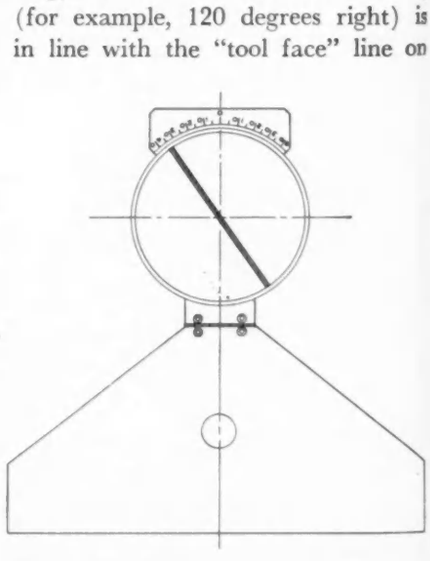


FIGURE 7—The protractor is used to measure the true angle between the face and the alignment bar.

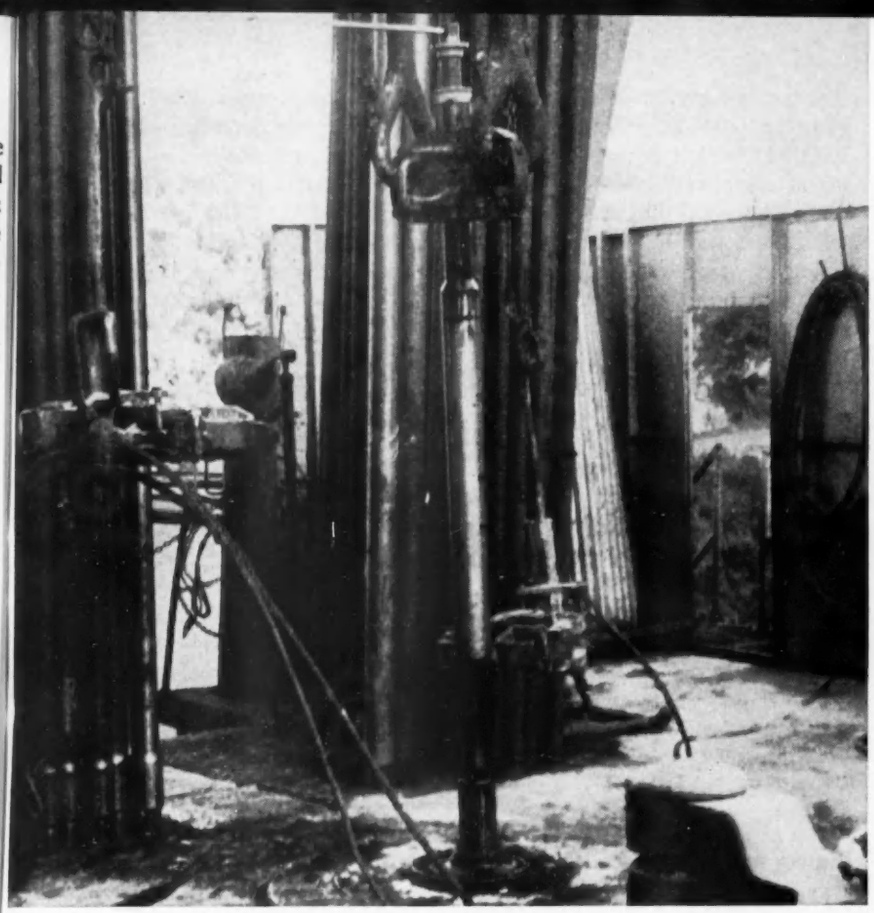


FIGURE 8—Orienting assembly hanging in the derrick just prior to going through the rotary table.

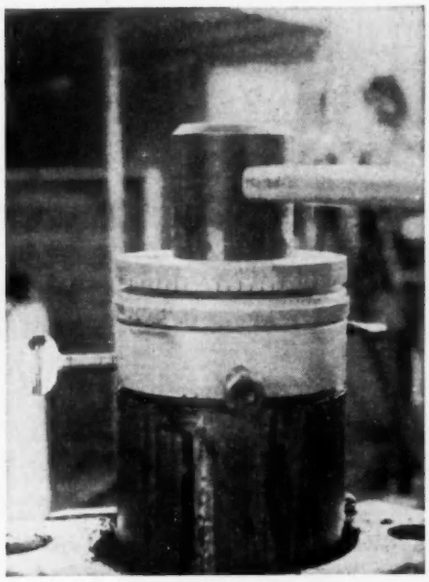


FIGURE 9—Protractor attached to the orienting assembly.

the index ring. The setting screws are tightened, and the tools are ready to be run in the hole.

The turning operation above places the index pin (and high side of the hole) 120 degrees behind the whipstock face, so the ball rolls from the high side when the whipstock is faced 120 degrees to the right from the high side of the hole.

Orienting tool on bottom. When the tool is on bottom, the kelly is attached, and low circulation started. A firm bottom is found and a mark placed on the kelly where it passes through the rotary table. The whipstock then is picked up off bottom (height depending on depth, drill pipe size and hole condition) and turned 45 degrees or less to the right. Bottom again is checked with the same weight used for the first tag.

This procedure is repeated until bottom is checked either one foot low (or high as the tool may reach bottom in the tripped position). When the first trip position is located, the rotary table and guard are marked and the whipstock picked up and rotated 180 degrees at this point. Bottom should check at the original depth. The whipstock then is turned 45 degrees ahead of the first trip position, and bottom checked.

Turns of 5 degrees - 15 degrees are now used, and the second trip position is located. If small turns are used, the whipstock may be sheared. Normally, a third check is made, making small turns and working out the torque between turns. Use of pumps makes turning easier and reduces torque. After the pin is sheared, the whipstock is drilled off in the normal manner.

Maintenance and storage of sub. When the tool is pulled, it should be washed thoroughly with water or distillate, depending on the mud base. If sand has settled around the wash pipe in the top sub, the tool should be taken apart and cleaned. The tool may be taken apart for field service by breaking the joints between the top sub and outer spline, and between the inner spline and lower sub. If the sub has been collapsed before breaking, the inner spline may be pulled out of the outer spline.

Otherwise, the lower setting screw is loosened and the interrupter lined up with the end of the setting plug to allow removal. Complete or shop assembly is accomplished by removing three snap rings, and unscrewing the cocking ring. —The End

About the Author

D. L. Sims was graduated from the University of Wyoming with a B.S. degree in mechanical engineering in June of 1940. He was employed by Logansport Machine Company, Hydraulic Valves and Power Equipment Division, from June 1940 to June 1941. Following military service he was employed by Eastman Oil Well Survey Company from November 1945 to November 1955. His last position was West Coast Division Mechanical Engineer. He left Eastman Oil Well Survey Company in 1955 and accepted employment with Regan Forge and Engineering Company as chief engineer.

Part 2

How to combat lost circulation while cementing

Field experience shows successful results of lightweight cement

By A. J. Willis
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R. A. Wynne
Division Superintendent, Drilling Specialties Co., Tulsa

ZONES SUSCEPTIBLE to lost circulation usually can be combated by lightweight cements. This can be accomplished by adding one of the several low density additives of which diatomaceous earth has proven to be successful. However, some types of lost circulation cannot be stopped by the use of lightweight cement alone and certain bridging materials must be used.

Bridging materials. Lost circulation zones containing large cracks must be filled with a bridging material before circulation can be restored. Experience gained with drilling muds through these zones can be of great value. Some types of crevices are filled most readily with flake-like material, whereas others are better sealed off with granular material. Experience gained with drilling muds through these zones can be of great value. Some types of crevices are filled most readily with flake-like material, whereas others are better sealed off with granular material. Experience gained while drilling should assist in determining which material to add to the cement. Recent experiences show that good results are obtained by adding combinations of flake-like and granular material.

Small amounts of lost circulation material have little effect upon the strength of cement (Table 8). Some preliminary laboratory experiments indicate flake-like material gives optimum results at about 1½ pounds per sack of cement; granular material works best at about 2 pounds per sack of cement; bituminous material works best at about 3 to 5 pounds per sack of cement; and cellular material, such as expanded perlite, seals at low pressure but the seal is broken when pressure is applied. However, this may not be true in actual practice since the depth of the fracture can be considered almost infinite as compared with the 1-inch depth of the fracture in the laboratory apparatus. Combinations of density-decreasing additives and bridging materials have proven satisfactory in the field.

Normally, the compressive strength of the cement when tested at temperatures less than 140° F can be considered about 50 percent greater if a suitable accelerator such as calcium chloride is used.

Salt-water cements. Zones of lost circulation many times are encountered immediately above and below

TABLE 5—Typical Chemical Analysis of Low-Density Cement Additives

	CHEMICAL ANALYSIS PERCENT				
	Diatomaceous Earth	Fly Ash	Natural Pozzolan	Perlite	Bentonite
Silicon Dioxide	89.0	43.2	44.0	71.4	61.8
Aluminum oxide	4.8	43.0	30.5	13.4	22.0
Iron oxide	1.8			1.7	4.3
Calcium oxide	0.8	5.9	10.2	1.3	1.3
Magnesium oxide	0.8	1.0	6.4	1.0	2.5
Sodium oxide	0.6	....	2.6	2.9	2.0
Potassium oxide	Trace	....	2.6	4.1	
Sulfur trioxide	....	1.7	Trace	....	1.0
Loss on ignition	3.0	3.0	....	4.2	4.8

TABLE 6—Penetration Depths of Bullets in Diatomaceous Earth and Neat Cements

Cement	Penetration, Inches At		
	1 Day	2 Days	3 Days
Neat	..	..	7
20 percent Diatomaceous earth	13	13	11
40 percent Diatomaceous earth	18	18	18

Cements cured at 140° F.

salt zones. When cementing through these salt formations, cement prepared from fresh water tends to leach away some of the salt, thus giving a poor cement-formation bond. Therefore, it has become a common practice to use saturated salt water to slurry cement to be used through salt sections. Because saturated salt water weighs about 10 ppg as compared to about 8.3 ppg for fresh water, the resultant cement slurries using saturated salt water are invariably of higher density than those using fresh water.

It, therefore, becomes increasingly difficult to obtain good cement slurries having low densities if slurries are prepared from saturated salt water. If, for example, a 50-50 fly ash cement containing 8 percent gel was slurried to 13.9 ppg with saturated salt water, an unstable slurry would result.[9] With fresh water this same slurry is recommended at a density of 13.1 ppg.

Naturally, as the amount of water in a cement slurry is increased, such as is possible with a diatomaceous earth cement slurry, the relative increase in density resulting from use of salt water in place of fresh water becomes more pronounced. For instance, a 40 percent diatomaceous earth cement which normally would have a density of 11 ppg has a density of 12.5 ppg when slurried with saturated salt water. A 60 percent diatomaceous earth cement slurry density is increased from 10.3 to 12.1 ppg. One striking feature of these slurries containing diatomaceous earth with large amounts of salt and water is that the strength of the cement slurried with saturated salt water is greater than the strength of the cement slurried with fresh water. For most cements, the strength when slurried with saturated salt water is only about half that when slurried with fresh water.[10]

Field experience. Development history of a small Wyoming field furnishes an example of the evolution of lightweight cements in the problems of controlling lost circulation. In this field, Well 1 was drilled to 9,231 feet where 9,229 feet of 5½-inch casing was set in a 9-inch hole. The casing contained a stage collar set at 7,641 feet. The first stage was cemented with ½ cubic foot of expanded perlite to one sack of 4 percent gel slow-set cement.

The same cement mixture was used to cement the second stage. While cementing the second stage, the plug was pumped to 1,300 feet when the casing pressured up to 3,000 psi and the cement could no longer be moved. It was estimated at that time that 60 barrels of cement had passed through the stage collar. Upon trying to reverse out, the formation took fluid at 100 psi. Failure of this stage cement job required 8 remedial squeezes, totaling 475 sacks of cement and 19 days of rig time to correct.

In the second well, 9,834 feet of 7-inch casing was run in a 9-inch hole. Sufficient expanded perlite-gel-slow set cement was mixed to bring the top of the cement back to 6,000 feet plus 100 percent. This slurry was mixed in the ratio of 1 cubic foot of expanded perlite to 1 sack of 4 percent gel cement. Top of the cement was found at 6,953 feet which required 3 remedial squeeze jobs totaling 500 sacks of cement to place the proper amount of cement behind the casing.

For the third job, 9,734 feet of 7-inch casing was set in a 9-inch hole. Sufficient 50-50 pozzolan cement with 4 percent gel was slurried to bring the top of the cement back to 6,000 feet with 100 percent excess. A temperature survey showed the top of the cement was actually 6,993 feet. This well required only 1 remedial squeeze of 500 sacks of cement.

In Well 4, 9,411 feet of 7-inch casing was run in a 9-inch hole. A metal petal basket was set at 7,893 feet and a stage collar was set at 7,885 feet. The first stage was cemented with 4 percent gel cement. The plug was not bumped as the ports in the stage collar opened, permitting circulation through the stage collar at 7,885 feet. The second stage was cemented with 4 percent gel. Circulation was lost when pumping the second stage when 89 barrels were left to be displaced.

Even so, a temperature survey showed the top of the cement to be at 5,887 feet. Sufficient cement was used in this stage to have circulated cement to the surface. Top of the cement was considered sufficiently high that no remedial squeezes were deemed necessary.

Almost the same casing program was run in the fifth well, when 9,422 feet of 7-inch casing was set in a 9-inch hole. This well was cemented in 3 stages with stage collars set at 7,679 and 6,542 feet with metal baskets set 7 feet below each stage collar. The first 2 stages were cemented with 4 percent gel cement, while the third

TABLE 7—Comparison of the Density and Compressive Strengths of Various Types of Low-Density Cements

Cement	Density,* Lb. Per Gal.	Compressive Strength,* Psi
1 cu ft improved perlite-1 sack cement with gel, percent		
4	12.9	540
8	12.6	350
12	12.2	240
1 cu ft improved perlite-1 sack 50-50 fly ash with gel percent		
4	12.6	210
8	12.4	150
Gel, percent		
10	12.95	1,050
12	12.6	620
Gilsonite in 4 percent gel, lb per sack		
25	12.6	880
100	11.0	390
Gilsonite in 50-50 fly ash, lb per sack		
25	12.5	620
75	11.2	220
Diatomaceous earth, percent		
15	12.9	1,210
18	12.6	940
20	12.4	840
30	11.7	570
40	11.0	380

* Density as measured at 3,000 psi.
24-hour compressive strength when cured at 140°F.

TABLE 8—Compressive Strength of 40 Percent Diatomaceous Earth Cement Will Vary With Different Types of Bridging Material.

Bridging Material	Compressive Strength,* Psi
0	380
Walnut shells, lb per sack	
½	320
1	370
1½	360
2	380
Cellophane scrap, lb per sack	
1½	350
1	330
1½	305
2	290
Improved perlite cu ft per sack	
⅛	370
¼	330
½	315
1	280

* 24-hour compressive strength when cured at 140°F.

TABLE 9—Properties of Diatomaceous Earth and Fly Ash Cements Slurried With Saturated Salt Water

Gel, Percent	Density, Lb Per Gal	Bleeding,* Percent	Compressive Strength,† Psi
40 percent Diatomaceous earth			
	12.45	1	420
	12.2	3	260
60 percent Diatomaceous earth			
	12.1	...	270
	11.9	...	200
50-50 fly ash			
8	13.9	3.5	280
12	13.85	2.0	200
16	13.6	2.5	160

* Percent supernatant water in 250-ml mixing cylinder filled with slurry for 3 hours.
This value should not exceed 1 for a stable slurry.
† 24-hour compressive strength when cured at 140°F.

stage was cemented with regular neat cement. A temperature survey showed no cement in the interval 6,542 to 6,740 feet. Three remedial squeeze jobs were necessary to place cement in this interval.

Wells 6 and 7 were cemented with 40 percent diatomaceous earth cement. In Well 6, 9,148 feet of 7-inch casing was set in a 9-inch hole; and in Well 7, 9,302 feet of 7-inch casing was set in a 9-inch hole. Both jobs were cemented in a single stage, with the top of the cement being at 5,770 feet in Well 6 and 5,395 feet in Well 7. No squeezing was necessary in either job.

Wells in western Kansas have been drilled to around 4,200 feet, cemented with 12 ppg diatomaceous earth cement, perforated in intervals very close together, and acidized.

An example is Phillips' Llanos 3 well in Sherman County, Kansas, where 7-inch casing was cemented at 4,950 feet in an 8¾-inch hole with a 12.4 ppg slurry consisting of 95 sacks of common cement with 20 percent diatomaceous earth. The Lansing-Kansas City formation was perforated in intervals 4,436 to 4,440 feet and 4,450 to 4,468 feet. A straddle tool was run on 2½-inch tubing, and the upper zone was acidized with 1,500 gallons at 750 psi maximum pressure after it had tested only 0.5 barrels of oil by swabbing. After acidizing, it tested 12 boph with no water. The interval from 4,450 to 4,468 feet swabbed 9 boph and 1 bwph without acid. The two zones together produced 16 boph and 1 bwph on swab test through 2½-inch tubing. These perforations were 10 feet apart.

In the Phillips Orinda 1 in Pawnee County, Kansas, 7-inch casing was cemented in an 8¾-inch hole at 4,053 feet with 40 sacks of common cement with 40 percent diatomaceous earth using an 11 ppg slurry. The Simpson formation was perforated from 3,983 to 3,997 feet and 3,972 to 3,978 feet. The well produced 8 boph from the Simpson formation before treatment. The well then was fractured with 10,000 gallons and 10,000 pounds of sand at a maximum pressure of 3,800 feet. After fracture treatment, this zone produced 13 boph.

The Lansing-Kansas City formation then was perforated from 3,943 to 3,953 feet and did not produce any fluid before acidizing. It then was acidized with 500 gallons at a maximum pressure of 900 psi. After acid treatment, it produced 10 boph and 5 bwph. The Lansing-Kansas City perforations were 19 feet from the Simpson perforations in this well.

A wildcat was drilled in Roosevelt County, Montana, through a salt section. A string of 7-inch casing was run in a 9-inch hole to 7,950 feet. Since the top of the salt section was at 5,780 feet, it was decided to run enough cement to obtain fillup to approximately 5,500 feet. From the caliper survey, and assuming that 150 percent excess would be required in the 220 foot section washed out to greater than 16 inches through the salt zone, it was calculated that 1,188 feet of slurry would be required to obtain the desired fillup. A saturated salt cement slurry was prepared by dry-blending 40 percent diatomaceous earth cement with 83 percent granular salt. A temperature survey was run approximately 14 hours after cementing was complete, which indicated the top of the cement at 4,820 feet. The average slurry weight was 12.3 ppg.

The program for testing the well included perforating and testing two intervals—7,621 feet to 7,627 feet and 7,640 feet to 7,650 feet—and to perforate and block squeeze below the 7,650-foot mark. The casing was perforated to block squeeze, but at 4,000 psi only ½ bwpm could be pumped into the formation. The casing then was perforated in the 7,640 to 7,650-foot interval and after testing was squeezed off. Ten sacks of cement were squeezed into the perforations at 5,000 psi. These small volumes and high pressures indicate the good shutoff that was obtained with the diatomaceous earth cement system.

Although there are a number of areas in the United States where it is common practice to use a bridging material with low-density cement, careful analysis of the jobs in these areas does not reveal that the bridging material was necessary where circulation had been completed before the cementing operation began. In all probability, a good low-density cement would have sufficed.

A study of these wells did reveal, though, that in a number of cases returns were lost while cementing with a bridging material incorporated in the cement slurry; whereas no returns were lost in the same area when a low-density cement was used. This was true even when the density of the cement containing the bridging material was the same as that of the slurry containing no bridging material. This seemed to be unique, however, inasmuch as in every case the bridging material was expanded perlite. This can be explained by an increase in the flow properties of the cement slurry containing the bridging material or by an increase in the slurry density down hole because of pressure crushing the small glass-like bubbles.

The analysis of various jobs throughout the country also reveals cases of bridging materials actually plugging the casing. This appears most prevalent in wells which have been dry-drilled. Perhaps the problem could be reduced by running a few sacks of cement which did not contain bridging material ahead of the rest of the slurry.

Summary

1. A more realistic approach to the strength requirement of cement has led to development of better low-density cement slurries. Largely through the use of these cement slurries, it now is possible to cement caing in a single stage which formerly required multiple stages.

2. It must be remembered that every type of cement formulation has a particular water-to-cement ratio that should not be exceeded. Far more cementing failures can be attributed to excessive water than can be attributed to insufficient strength.

3. It is not good practice to tail in a production string with a heavier cement because, by and large, lightweight cements have for better perforating characteristics than heavier cement slurries.

4. When compared at the same slurry density, lightweight cements containing diatomaceous earth are stronger.

5. Cement blends high in aluminum are susceptible to deterioration by corrosive waters. Of materials used for lightweight cement slurries, only diatomaceous earth improves resistance of all cements.

6. Where circulation is complete before cementing has begun, bridging materials are of little value. Where bridging material is necessary, small concentrations—up to five pounds per sack of cement—have proved most successful.

(This article was condensed from the paper "Combating Lost Circulation While Cementing in the Mid-Continent," presented at the Spring meeting of the Mid-Continent District

Division of Production in Amarillo, Texas, April 22-24, 1959. The authors wish to thank the management of Phillips Petroleum Company and Drilling Specialties Company for allowing them to prepare and publish this paper.)

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High Temperature Drilling Fluids

Continued from Page 119

date the volume expansion of the fluid phase resulting from an inrease in temperature. A 200-pound gage on the back pressure device was replaced with a 1,500-pound gage so higher back pressures could be applied.

Similarly, unpressurized high temperature storage cells were found to give questionable and anomalous data, particularly at temperatures above 350° F. Mud samples aged in this type of cell generally had higher viscosities, gel strengths and yield points, and lower pH values than identical samples aged under an applied pressure equal to the vapor pressure of water at the storage temperature. Table 8 demonstrates these differences both in a gypsum-ferrochrome lignosulfonate mud and a lignite-sodium-surfactant mud. The conventional unpressurized storage cell and the pressurized storage cell used to obtain data in this study is shown in Figure 4.

It must be emphasized that these static aging tests, whether pressured or unpressured, give only relative data and are not considered a true representation of actual flow properties at elevated temperatures. This is due to the fact that, in following present procedures, it was necessary to cool samples below a temperature of 212° F. before determining shear strength or rheological properties. The static storage at high temperature is valid in that the drilling mud approaches bottom hole temperature only when left in the well for a period of time. Cooling the mud before measuring shear strength is not valid because the mud in the well must move up the hole before it can cool, thus any gel strength is broken while the mud is at maximum temperature. Chemically treated muds exhibited minimum viscosities at higher temperatures than did untreated muds.

As more interest in high temperature mud systems is shown, there will be a greater need for testing equipment that permits determination of rheological properties while fluids are being subjected to extreme temperatures.

Special testing procedures were followed to obtain more accurate data at the high temperatures studied. Distillation was found to occur across the filter cake in muds filtered above 350° F. when a 100 psi back pressure was applied. This was corrected by applying 425 psi (the vapor pressure of water at 450° F) to all samples filtered between 350° F. and 450° F. Various initial pressures, depending upon test temperatures, were applied before heating the samples in order to prevent boiling of the mud and to maintain a final differential pressure of 500 psi. The initial pressure necessary to meet these requirements was determined from Table 9.

TABLE 9—Table for Determining Initial Applied Pressure on High Pressure High Temperature Filtration Cell

Temperature	Differential Pressure (psi)	Back Pressure (psi)	Steam Pressure (psi)	Initial Pressure (psi)
350.....	500	425	135	790
400.....	500	425	250	675
450.....	500	425	421	504

In obtaining storage data at extreme temperatures, aging cells were pressured initially with a pressure equal to the vapor pressure of water at the temperature at which the tests were to be conducted. Nitrogen gas was used to pressurize both the filter cells and the static aging cells.

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Mohole Project

Can the earth's "crust" be penetrated?

Yes, within four years, say some of the nation's top scientists—providing oil industry know-how and equipment can be obtained

By Don E. Lambert
Associate Editor, WORLD OIL

OIL INDUSTRY know-how and equipment are expected to play a major role in drilling more than four miles through the earth's crust to the Mohorovicic Discontinuity or "Moho," and the Mantle below.

The first official report on the "Mohole" project was presented September 9 at a meeting of the International Oceanographic Congress in New York. Following are excerpts from that report, including ways in which the oil industry may participate in the project:

Although several sites in the Atlantic and Pacific oceans have been studied, the drilling location that presently seems to meet the established criteria is in the general area between Clipperton and Guadalupe Islands west of Mexico.

In that area the depth to the Moho is approximately 35,500 feet, including 10,700 feet of water, 200 feet of soft sediments, 6,100 feet of "second layer" material, and 18,500 feet of "third layer" or "crust." Whether there are fewer or more than three layers of material between the ocean floor and the Moho, and what they

The Mohole Plan

During the past several months, working groups of the National Academy of Sciences and the National Research Council have been conducting studies to determine ways and means to reach the "Moho" objective.

In a recent report, the AMSOC Committee stated it will be possible to drill in 10,700 feet of water through more than four miles of the earth's "crust" within four years if the following plan is carried out:

SEQUENCE OF OPERATIONS

Preliminary work already is underway. This includes studies of how an existing drilling ship can be modified, explorations of the crust in promising areas by oceanographers, and examination of promising ideas.

Beyond completion of that work, plans are more general because they depend upon availability of funds. Three major phases are planned for which approximate times and costs have been estimated.

Phase I will consist of modifying a drilling ship for deep-water operations. With it the first holes will be drilled with a drill string not exceeding 18,000 feet in length. Primary purpose of this work will be to test equipment and to obtain engineering design data.

Holes will be drilled in several locations of varying characteristics using different techniques. For example, rotary and turbo drilling methods will be compared; various coring devices will be tested. Until such data are obtained by direct experiment at sea, no one knows how to proceed with design of a rig that will be capable of reaching the mantle more than two miles deeper.

The scientific objective of Phase I is to core as deeply as possible into the ocean bottom. It is hoped that the drill will completely penetrate the sediments and much of the second layer in a number of places.

In the area between Guadalupe and Clipperton Islands an 18,000 foot drill string should bring up cores of the top of the third layer. Since the difficulties of drilling to the mantle depend upon hardness of the rocks and the number of strings of casing that will be needed, this is also a critical piece of engineering data.

If continuous undisturbed oriented core samples are obtained by this test, and if instruments lowered into the hole return the information expected, a large part of the objective of the AMSOC Committee will have been attained.

It is possible that sudden revelation of the geologic history of uppermost layers will generate so much scientific excitement there will be a general clamor to drill at many places beneath the ocean. But after deep-drilling techniques are worked out and the third layer is sampled, the committee's attention will turn to deep rocks.

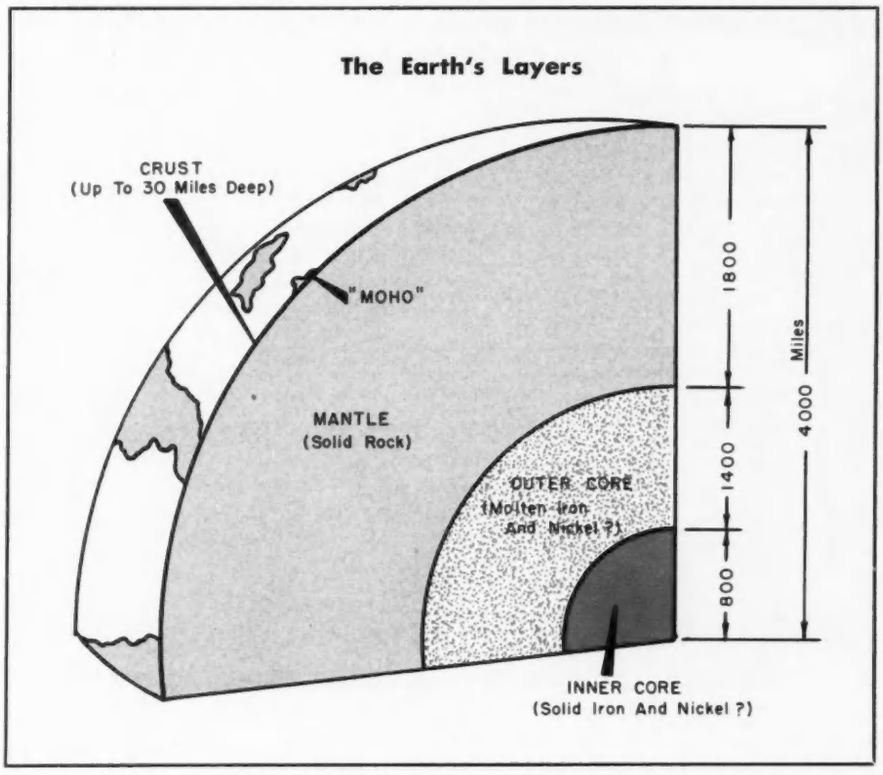
Phase II will begin with application of engineering

consist of, is still a matter of conjecture among scientists.

Provided funds and equipment can be obtained in a reasonable length of time—and the proposed plan for the project is carried out—sponsoring groups believe the Moho objective will be reached within four years.

How project started. During 1958 the informal deep drilling committee of the American Miscellaneous Society was given formal status as the AMSOC Committee of the Division of Earth Sciences of the National Academy of Sciences. Funds were made available by a research grant from the National Science Foundation to make a study of the desirability and feasibility of drilling a hole to the Moho.

The AMSOC Committee held several meetings last year, setting up preliminary studies and selecting panels to obtain specific information, and to bring more scientific talent to bear on



data found in Phase I to design of a new drilling ship. All who are involved in the drilling business (equipment suppliers, drilling contractors, oil companies) will be interested in this design for it will utilize the best deep-drilling equipment that can be assembled.

A ship will be built (probably an existing hull will be rebuilt). It will undergo shakedown tests, and finally will move into position on the selected site, where it will drill to the mantle.

Phase III covers the scientific direction of the work and analysis of results: It begins with the drilling of the first test holes in deep water and continues until all data have been analyzed and the final report submitted. Generally it will include the continuous inspection of all drilling, the detailed analysis of cores, synthesis of results and publication of findings.

MANAGEMENT

The AMSOC Committee under guidance of its parent body, the National Academy of Sciences—National Research Council, has assumed responsibility for management of the deep drilling project.

The Academy-Council is a well established meeting point for the scientists and engineers of many disciplines and institutions who will be involved in this complex project. Moreover, it is able to accept and integrate public and private funds with a minimum of overhead and confusion.

On June 14, 1959, the Governing Board of the National Academy of Sciences granted permission for the AMSOC Committee to proceed with the project as conceived and to ask for supporting funds as needed, beginning immediately with Phase I.

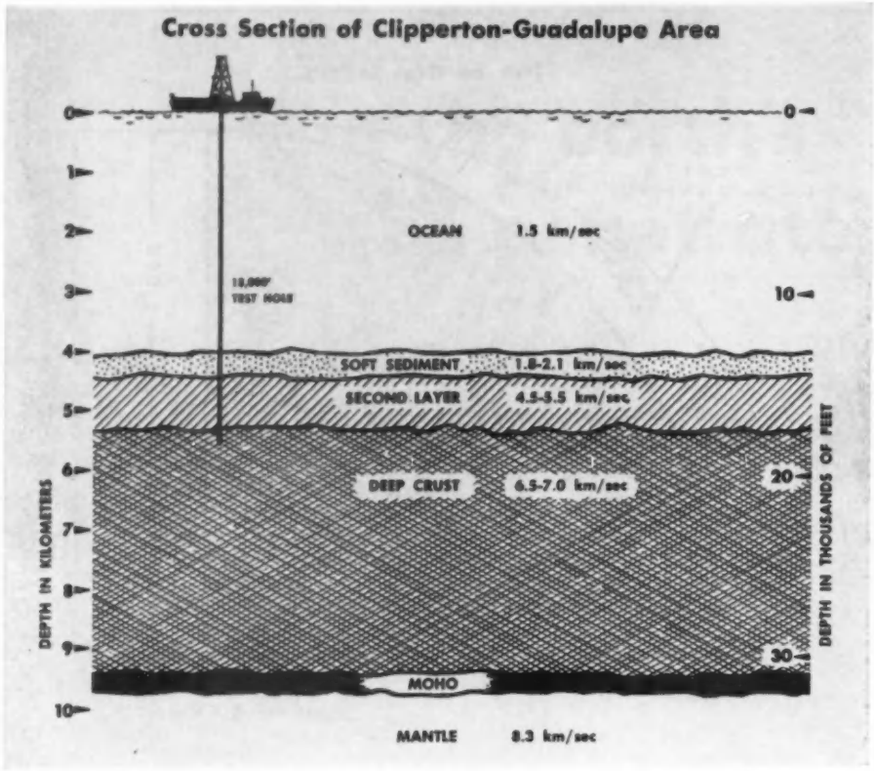
FINANCING

Funds required for the project are estimated at $15 million. This is only an approximation since an estimate of the cost of Phase II depends on what is found in Phase I.

Until detailed engineering studies are made that designate specific equipment, and until a contract is drawn which defines ownership of the additional equipment and daily rates which a drilling contractor will be paid, no one can make a more meaningful estimate. How many days drilling will be required will depend on what is found, on weather, on design of deep sea equipment, and on luck.

Contributions of equipment and funds by many interested groups are expected. For example, the U.S. government may be willing to contribute a suitable ship from its stockpile for Phase II and suppliers of bits, pipe and machinery appear to be eager to contribute to the project.

The Office of Naval Research, through its general sponsorship of scientific work at sea, probably will underwrite some of the scientific analysis. The National Science Foundation has shown great interest and probably will support appropriate parts of the project.



deep drilling problems. Two panels, site selection and scientific objectives and measurements, are now operating. Other panels will include drilling, financing and encouraging industrial participation.

Benefits to be obtained. According to the AMSOC Committee, there are three general ways of stating the scientific values of directly exploring the depth of the crust and the outer edge of the Mantle:

1. Scientists are not sure what they know about types of rock formations at great depths. All the indirect evidence that has been so carefully marshalled in support of present theories needs to be confirmed by direct measurements and examination of actual specimens of rock.

When scientists are certain what each layer is composed of, the great mass of information that has been so painstakingly and expensively obtained over a period of years will be tremendously enhanced in value. Differences in geological concepts can be resolved.

2. Much remains to be known about the sub-oceanic rocks and the record they contain. Without taking direct samples it may not be possible to work out the history of the ocean basin. There is, for example, no indirect means of determining the progress of evolution; fossil evidence is required.

3. There is a chance for some great unexpected discovery. The history of science has repeatedly demonstrated that unpredicted discoveries which upset accepted theories are the most valuable results of venturing into the unknown.

In addition to the above benefits, the oil industry will have an opportunity to profit from an experimental work which may lead the way to faster, better and cheaper techniques for deep drilling, coring and working with deep water facilities and equipment.

New information about the origin and extent of petroleum deposits may be discovered.

Oceanographers and others who work at sea will be helped by the new techniques for doing heavy work in deep water, and by the accumulation of data during drilling. The value of the information and experience which will be gained will greatly outweigh the cost of obtaining it.

Feasibility of project. After months of preliminary study, the AMSOC Committee reports it believes it is feasible to drill a hole to the earth's mantle beneath the ocean.

The principal objective would be to obtain continuous oriented samples of rocks in the crust, in the Mohorovicic Discontinuity, and the outer part of the Mantle. Although the minimum depth to the ultimate objective would be several thousand feet deeper than any hole yet drilled, the committee believes that if the best of modern drilling equipment is assembled, the Mantle can be reached.

Difficult drilling problems will be encountered such as taking continuous cores in both very hard and very soft rocks at great depth. Ship problems, including the holding of position at sea within a small area and of weathering storms, must be met. Also, how to support and steady the riser pipe against substantial deep currents needs to be resolved.

However, in the words of AMSOC Committee, "There are no physical reasons why these problems cannot be solved by imaginative engineers armed with design data obtained by drilling a number of experimental holes with presently available equipment."

Drilling needs. Deep water drilling facilities and equipment are needed that can lower and orient (by using the drill pipe) loads of more than 100 tons. It should be possible to create differential pressures at the bottom of several thousand pounds per square inch; to pump water to the surface from any depth at many hundreds of gallons per minute; to drill holes in the ocean floor and fill them with concrete for foundations; to maintain a fixed position at sea for long periods, and to orient the drilling facilities at a position where they are least affected by winds and waves.

Although no specific need for such capabilities has been identified, it is evident that once they are available many uses will be found. It is likely that they will contribute substantially to the eventual harvesting of the mineral wealth of the oceans.

Available facilities. In recent years the search for oil in increasingly deeper water on the Continental Shelf has led to the development of floating drilling platforms mounting full-sized drilling rigs. Four of these are at work today, drilling in water depths of 35 to 350 feet and penetrating the underwater sediments as much as 12,000 feet.

Two of these drilling units, Cuss 1 and Nola 1, are completely self-contained. Both are on YFNB hulls (260-foot length x 48-foot beam x 10.5-foot draft, displacing 3,000 tons).

Cuss 1 has a drawworks rated at 12,000 feet with 4½-inch pipe, 98-foot derrick, drills through a center wall, racks its pipe horizontally, and moors with ten 7,500-pound anchors.

Nola 1 has a drawworks rated to 15,000 feet with 4½-inch pipe, a 140-foot derrick, drills over the side (load on derrick counterbalanced by pumping water into a sponson on the opposite side), stands its pipe in the derrick and moors with eight 10,000-pound anchors.

Probably either of these vessels could be modified so total reach of the drill would be 18,000 feet. If means of holding the ship in position where the water is over two miles deep can be found; if certain changes are made in derricks and winches, and, if methods can be worked out for handling long pipe strings under water, it will be possible to drill several thousand feet into the ocean bottom and to obtain valuable scientific and engineering data at relatively low cost.

For example, samples of each of the soft layers would be obtained which would give information about how cores can be taken, how well the walls of the hole will stand without casing, how difficult it will be to drill in each layer. Data could be obtained on relative values of using turbodrills, sound drills or conventional rotary drills. Valuable oceanographic data about wave and current forces on the ship and the pipe—and on difficulties of holding position at sea will be obtained.

Having obtained this data by drilling several relatively shallow holes, it will then be possible to establish a complete set of design requirements for the Moho drilling job. Following these, a new rig utilizing the best equipment will be designed to drill deep into the sea floor.

As a general policy, the AMSOC Committee is reluctant to depart too radically from accepted drilling procedures or to engage in any substantial development program. It simply intends to assemble the most appropriate equipment to do the scientific job at hand.

In addition to facilities already in existence, several major companies have prepared detailed plans for improved drilling vessels and have tested models in wave-tanks. It is hoped that this experience will be available to the Moho project.

Equipment requirements. Staff studies of some of the more detailed aspects of deep drilling at sea are now being made on such diverse subjects as use of turbodrills and sound drills, sea water as a drilling fluid, aluminum pipe, wire-line corers and ship positioning devices.

Obviously it would be convenient if salt water could be used as a drilling fluid. Below the sediments (which probably will have to be cased immediately) in the homogeneous igneous rocks, it is hoped that the walls of the hole will stand up without the differential pressure of a high-density drilling mud.

As long as the bit is capable of drilling, coring can continue. In holes deeper than 10,000 feet it is not unusual to make a round trip with a wireline core barrel in one-tenth the time it takes to round trip the drill pipe and change a bit. Because of the necessity of taking continuous cores at great depths, it would be advantageous to use the wire-line method.

Since it is possible that whip and vibration caused by a rotary drill string will make rotary drilling undesirable, two other methods are being studied:

1. The turbodrill, rotated by the flow of drilling fluid down the pipe, is in general use in Europe. One recent development by a French company is wire-line coring through a diamond bit equipped turbodrill.

2. A drill with the bit vibrated at high frequency by the flow of drilling fluid, is another possibility. Certain advantages are claimed for this method in coring and in drilling through igneous rocks.

It may be necessary to use more automatic devices on the drilling ship than are customarily used in oil field work. Motion of the ship may make some of the manual operations hazardous.

Perhaps several of these machines and techniques (turbodrill, aluminum drill pipe, sea water circulation, automated handling, over-the-side pipe racking, diamond bits, wire-line corers) can be combined in the undersea drilling operation to achieve maximum efficiency.

One problem of drilling in the deep sea will be holding the ship in position. A horizontal motion of the ship about a point directly above the hole of not greater than 2 percent of the depth (240-foot radius in 12,000 feet of water) is believed to be permissible.

A study of this problem has considered both static anchoring systems and dynamic position systems. In the first case it may be possible to use hawse lines made of synthetic, neutrally-buoyant fibers attached to special anchors which are jetted into the bottom.

The dynamic system seems to be more promising because of its greater flexibility and small investment in non-recoverable items. In this method a ring of taut-line deep-moored buoys about 1,000 feet in diameter would be installed in advance around the drill site by an auxiliary ship.

The drilling ship, equipped with several large outboard-type motors (able to rotate thrust 360°) or two vertical-axis propellers, would move to the center of the buoy ring. By watching the buoys a pilot should be able to maintain the ship's position within the design limits regardless of abrupt shifts in the direction of wind and current. Auxiliary anchors to hold the ship in very calm conditions or against a steady current also might be used.

In addition to the development of a concept and investigation of specific equipment that might be used to carry it out, there have been other forms of progress. An operating office has been established and a staff is being built up to assist the committee in management of the project.

As a result of the general public interest which is being aroused, several industrial firms have made generous offers of assistance. For example, the Electromotive Division of the General Motors Corporation has offered to lend the committee $1 million worth of diesel-electric power equipment.

The Global Marine Exploration Company has received a contract from the Office of Naval Research (with funds partly contributed by the Army's Office of Research and Development) to study how Cuss 1 could be adapted to deep water drilling operations. A report will be made this fall. —**The End**

Why not store offshore oil

Cavity wells of at least 300,000 barrels capacity would allow tankers to load on location at sea. Increased ultimate recovery, reduced operating costs are additional features

By G. H. W. Schuster
Petroleum Regulatory Engineer
U. S. Geological Survey
New Orleans

A RECENT SURVEY has confirmed the feasibility of a new method for storing oil produced offshore in the Gulf of Mexico. Essentially, the procedure consists of leaching storage caverns in centrally located salt domes, and using these caverns in lieu of platform or floating barge storage facilities. Oil storage in salt domes offers these advantages:

- Cost per barrel of offshore storage would be reduced considerably.
- Operating costs would be reduced.
- Oil could be transferred directly to tankers at sea, eliminating barging produced liquid hydrocarbons to onshore pipe line terminals.
- Weather, which precludes barging operations about three months a year, would affect tanker operations only a few days a year (when hurricanes occur).
- Wells could be produced at MER, which would result in higher ultimate recovery, increased economy and systematic development of participating oil fields. Oil would be withdrawn from storage at prevailing allowable rates.

As indicated in Figure 1, the procedure would be most applicable in

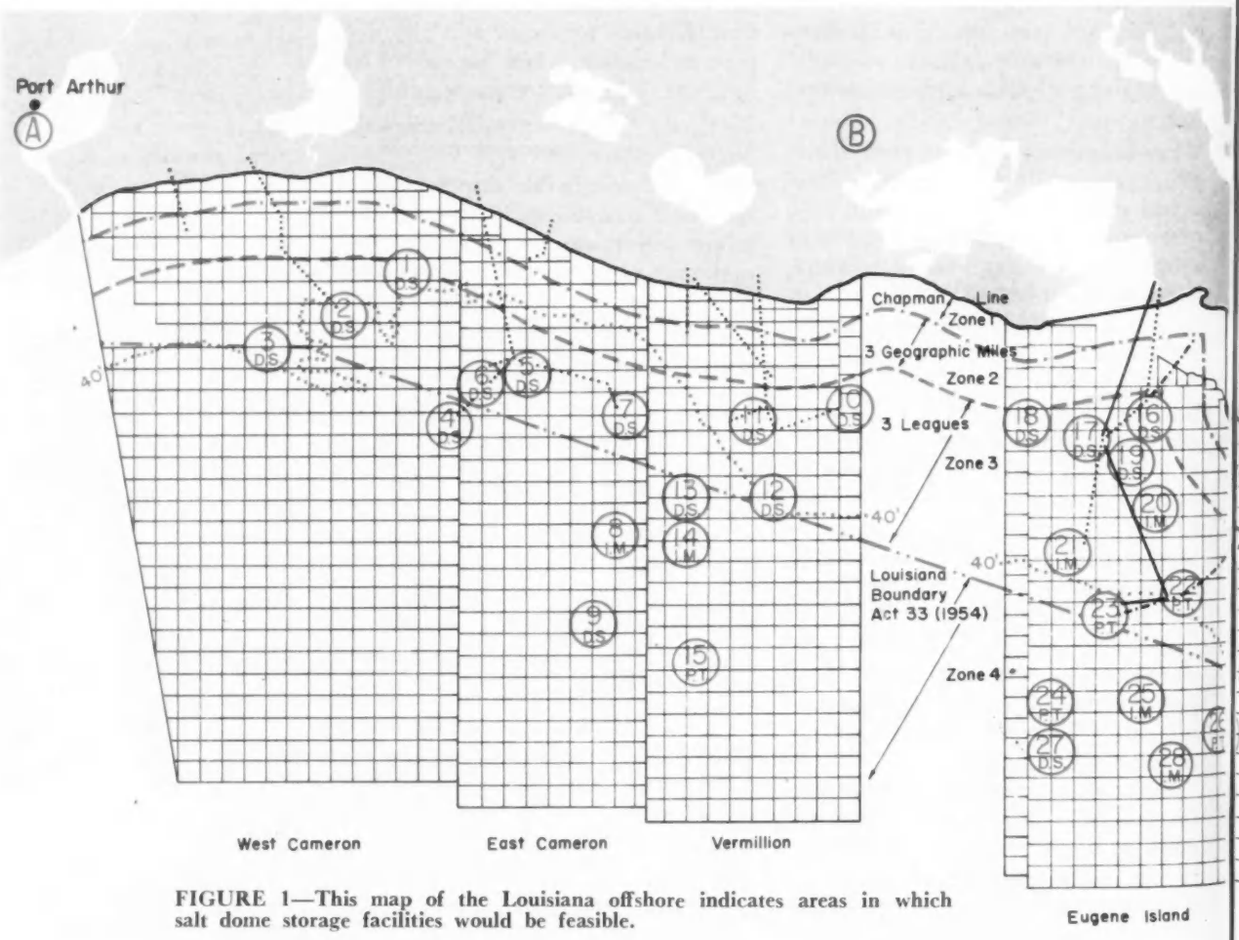


FIGURE 1—This map of the Louisiana offshore indicates areas in which salt dome storage facilities would be feasible.

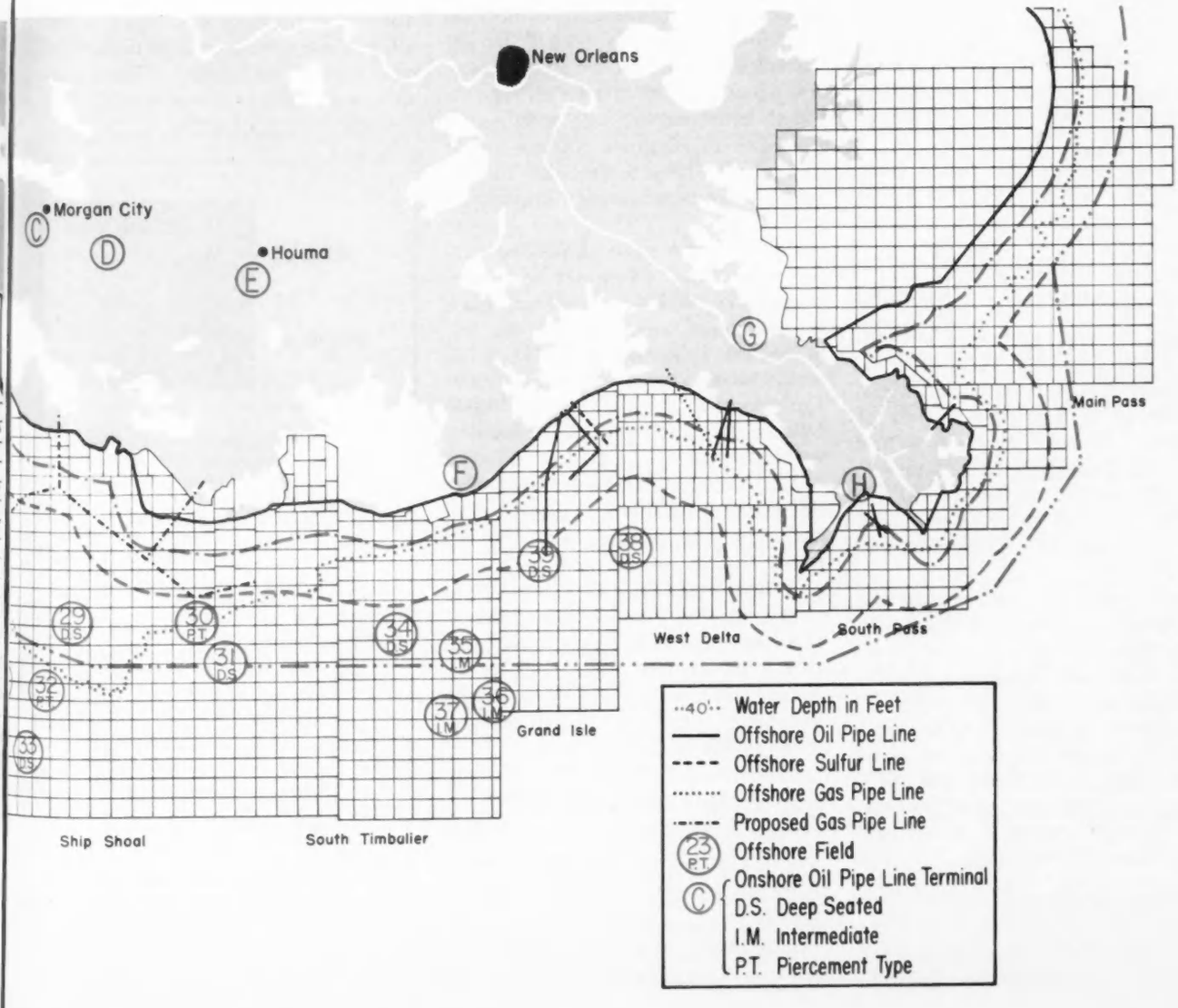
in salt domes?

zones 3 and 4 of the outer continental shelf (and areas farther at sea) off Louisiana. Oil production is expensive in this area, even after discovery in commercial quantities. Transportation costs are major items affecting operating economy. This is particularly true as new fields are discovered farther from shore.

Transportation. Present offshore practice is to transport produced crude oil to onshore pipe line terminals, either by pipe line or barge. Barging costs for oil from zones 3 and 4 average about 35 cents per barrel. Offshore pipe lines can reduce these costs only where large volumes of oil can be transported daily for a number of years. Substantial production rates and large reserves are a necessity if such lines are to pay out in a reasonable length of time. Since new fields are being discovered ever farther from land, oil pipe lines appear to be economically unattractive and comparatively few have been built.

Sea going tankers offer the most economical means of transporting produced offshore oil. Tanker freight is estimated at approximately 12-14 cents per barrel, F.O.B. Gulf Coast or New Orleans and Baton Rouge refineries. A number of companies have investigated the possibility of collecting and storing oil in leached salt dome cavities offshore, and transfering this production to tankers which would load on location at sea. However, these investigations have not resulted in commercial application to date.

Based on the idea of a group operation, which has in the past proven advantageous in a number of joint offshore ventures, it has been suggested that offshore producers cooperate in a common gathering and salt dome storage system. Oil would be produced into chambers leached in centrally located domes. Tankers would collect this production for direct shipment to refineries. Production and storage of oil in these leached caverns shows challenging possibilities since production costs would be



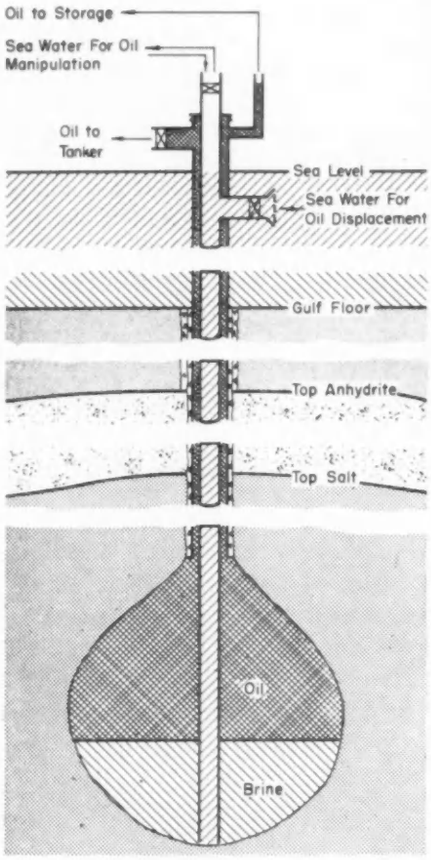


FIGURE 2—In the future, oil produced offshore may be stored in salt cavity wells located in the Gulf of Mexico. The type of well shown here could be used as storage for several fields, and tankers could load directly at sea by displacing oil with sea water.

reduced and higher ultimate recoveries would result.

Storage. Dissolved chambers in shallow salt domes provide ideal underground storage. At present, 36 million out of 42.5 million barrels of subsurface storage capacity is in salt domes. All anomolies with a proven accumulation of hydrocarbons in zones 3 and 4 of the Louisiana offshore area are shown in Figure 1 and listed in Table 1.

Initial minimum storage capacity for individual storage centers should be equivalent to the maximum sized tanker to be used plus one month's production of participating fields. If T-2 tankers (payload 120,000 barrels 35 gravity crude) are used for transport, and the facility serves a monthly production of 150,000 barrels, a minimum storage capacity of 300,000 barrels would be required.

Leaching. Considerable experience in leaching caverns in salt domes has been acquired by many operators in preparing LPG and gas storage facilities. Oil storage would be leached in the same manner. A typical installation is shown in Figure 2.

Cost of a dissolved chamber in a salt dome (2,000 feet deep) with an initial storage capacity of ± 300,000 barrels is estimated to be $700,000. This is considering the location to be in 75 feet of water and would include a small platform and tanker loading facilities. The estimate also assumes that 16-inch and 11¾-inch casing were used in completing the storage well. The figure is practical when considering offshore costs.

It is assumed that each central storage facility would serve several companies. Thus, the cost of the project could be divided proportionately among participants, and actual cost to individual producers would be reasonable. Also, storage caverns could be enlarged cheaply and rapidly since the only additional expense would involve operating costs of pumps for leaching purposes.

If more than one grade of oil is to be stored, a corresponding number of individual chambers would be required. In operation, the storage cavern would be completely filled with liquid hydrocarbons above brine or sea water at all times. Storage above concentrated brine is necessary to prevent further expansion of the chamber by leaching.

Use of brine as a displacing medium for stored oil would be uneconomical on offshore locations, since an additional cavern would be required for brine storage. Also, brine would have to be lifted from the storage cavern at the high rate of 10,000 bph to meet minimum tanker loading requirements.

Sea water is an ideal displacing medium for oil stored in the caverns, as long as the leaching action of the water (in the storage cavern) can be tolerated. Since the base of the salt in the Gulf Coast area is well over 40,000 feet below sea level, and a typical salt core is one to four miles in diameter, there should be no serious objection even to a very substantial enlargement of the storage facility.

Introduction of 150,000 barrels of sea water per month into the storage cavity to displace an equivalent amount of oil into a tanker would increase storage capacity (through leaching action of the water) by approximately 140,000 cubic feet. This is equivalent to a cavern 52 x 52 x 52 feet. The original cavern space of 300,000 barrels would be doubled in one year and enlarged to 3 million barrels capacity (equivalent to a cavern 256 x 256 x 256 feet) in ten years.

A differential pressure of approximately 150 psi is exerted by a 2,000-foot column of salt water (S.G. = 1.026) acting against a 2,000-foot column of oil (S.G. = 0.85). If a storage facility is about this deep (2,000 feet), the 150 psi differential pressure would be available for displacement of stored oil.

As discussed previously, sea water used to displace oil from the cavern will leach salt from the cavern walls. This will cause an increase in the specific gravity of the water. As an example, assume that the gravity of the water contained in the cavern is increased to 1.20. By comparing the hydrostatic heads exerted by 2,000-foot columns of water (S.G. = 1.20) and oil (S.G. = 0.85), it can be seen that a back pressure of about 300 psi would have to be overcome to introduce oil into the cavern. Since almost all offshore producers are capable of overcoming this amount of back-pressure, wells could be produced directly into the storage caverns.

About the Author

G. H. W. Schuster was graduated from the Technical University of Berlin in 1925. He was employed by Shell Oil Company from 1925 until 1933, working in Rumania, Indonesia and the United States as a petroleum engineer and field manager. From 1933 to 1939 he operated his own technical wholesale house in Munich, Germany. He was employed by the Carpathian Oil Company in Poland from 1939-1945, where he worked in technical and administrative management. From 1945-1948, he worked in technical and administrative management of the Wirtatobel coal mine in Austria. From 1948-1957, he worked as a geophysicist for Western Geophysical Company in the United States. In 1956, he obtained a leave of absence from Western and returned to Vienna to head the drilling department of the Austrian Mineral Oil Administration. Since 1957, he has worked as a petroleum regulatory engineer for the U. S. Geological Survey.

TABLE 1—Anomalies listed here are located in zones 3 and 4 of the Louisiana offshore area (Figure 1), and all have proven production. Since they are located a considerable distance from shore and only limited pipe line outlets are available, most could qualify as candidates for salt dome oil storage facilities.

No.	Area	Field	Zone	Water Depth	Approx. Top Salt	PRODUCING		SHUT-IN		Operator	PIPELINE	
						Oil	Gas	Oil	Gas		Oil	Gas
1	W. Cam.	71	3	40′	Deep-Seated	..	..	1	7	Superior	..	x
2		110	3	40′	Deep-Seated	..	14	..	1	Magnolia/Pure	..	x
3		149	4	40′	Deep-Seated	..	..	..	14	Superior	..	x
4		192	4	55′	Deep-Seated	..	29	2	5	CATC/Shell	..	x
5	E. Cam.	49	3	50′	Deep-Seated	..	1	..	..	CATC	..	..
6		62—64	3	50′	Deep-Seated	..	10	..	10	CATC/Magnolia	..	x
7		71	3	53′	Deep-Seated	..	8	..	..	CATC	..	x
8		126	4	70′	—6000′	..	..	..	1	Pure	..	..
9		160	4	84′	—4000′	..	..	1	4	Calif./Gulf	..	..
10	Verm.	71	3	20′	Deep-Seated	..	..	..	2	Superior	..	..
11		76	3	20′	Deep-Seated	..	17	..	3	Union Cal./Pure	..	..
12		96	3	30′	Deep-Seated	..	..	..	..	Cont.	..	..
13		102	4	66′	—8000′	..	..	..	1	Union Prod./Supr./Cont.	..	..
14		120	4	70′	—2500′	11	..	2	..	CATC	..	x
15		164	4	90′	— 560′	..	..	2	1	Calif./Shell	..	..
16	Eug. Isl.	32	3	10′	Deep-Seated	13	13	1	1	Pure/Sun	..	x
17		45	3	20′	Deep-Seated	3	3	1	..	Magnolia	x	..
18		47	3	20′	Deep-Seated	..	..	..	1	Tex.	..	..
19		53	3	20′	Deep-Seated	..	..	..	1	Union Prod.	..	..
20		77	3	20′	—1650′	..	..	1	4	Humble	..	..
21		110	3	20′	—2600′	1	3	8	4	Magnolia/Calif./Odeco	..	x
22		126	3	35′	— 275′	79	..	7	2	Magnolia	x	..
23		128	3	50′	.....	39	..	14	6	Magnolia/Shell/Placid	x	..
24		175	4	78′	— 230′	4	..	..	3	Sinclair/Shell	..	..
25		184	4	72′	—4000′	..	..	..	4	Phillips	..	..
26		188	4	66′	— 900′	15	..	3	2	Sinc./Phil./Shell	..	..
27		198	4	90′	Deep-Seated	..	..	2	3	Placid/Pan Am.	..	..
28		208	4	90′	—5000′	..	..	8	..	Continental	..	..
29	Ship Shoal	107	3	20′	Deep-Seated	..	..	1	..	Calif.	..	..
30		113	3	45′	— 500′	2	..	..	..	Magnolia	..	..
31		139	3	60′	Deep-Seated	..	..	..	1	Shell	..	..
32		154	4	55′	— 200′	43	1	5	1	Gulf/Sinc./Forest	..	..
33		176	4	90′	Deep-Seated	..	..	5	..	Gulf/Cont./Humble/Tex.	..	..
34	S. Timb.	54	3	66′	Deep-Seated	4	..	6	1	Humble	..	..
35		86	3	90′	—4000′	5	..	..	..	Sinclair/Calif.	..	..
36		131	4	140′	—3—4000′	16	..	1	..	Gulf	..	..
37		135	4	120′	—3—4000′	3	..	..	1	Gulf	..	..
38	Grand Isle	43	3	120′	Deep-Seated	..	..	3	5	Continental	..	..
39		47	3	90′	Deep-Seated	56	..	10	3	Continental	x	..

All anomalies not showing Approx. Top Salt are termed Deep Seated, even when there is no evidence they are caused by salt intrusion.

ONSHORE OIL PIPE LINE TERMINALS

A Port Arthur
B Intra-Coastal City
C Morgan City
D Gibson
E Houma
F Bay Marchand
G Ostrica
H Southwest Pass

Loading. Loading of tankers which would anchor adjacent to the storage well platform would pose no special problems. Floating hoses, metering equipment, etc., now available would be used.

Sea water would be used to displace oil from the storage cavity directly into the tanker. Casing and tubing programs of the wells should be designed to deliver required volumes of oil to the tankers. Of course, the vast experience of LPG and gas storage well operators would be invaluable in the design of a salt dome storage facility.

Oil could be gathered from surrounding fields into a central storage well by barge, small tanker or flow lines. Flow lines probably would be the most convenient and trouble-free method since weather would have no effect upon them. Automation of all producing facilities and LACT would provide additional benefits.

Production. At present, two LPG storage wells of 1 million barrels each are being leached in a Texas salt dome. There is no reason this volume should be considered an economic maximum.

One operator has suggested that storage caverns of 30 to 50 million barrels capacity be leached. This would allow production and depletion of the surrounding fields at MER. Withdrawal from storage caverns would be at prevailing allowables.

Production at MER would make possible:

1. Systematic and timely development of participating fields.
2. Reduction in operating costs.
3. Higher ultimate recovery.

Corrosion is a major problem in the Gulf. Some operators fear that field productive life will be in excess of the life of conventional producing facilities. Production at MER probably would deplete most fields within the usable lifetime of the original facilities, thus saving considerable expenditures for replacement of corroded equipment.

Since gas would be available in substantial quantities, gas pipe lines might be extended farther into the Gulf thus allowing recovery and sale of natural gas and gasoline from points far offshore. Gas not sold might be used for pressure maintenance or recycling purposes.

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South Michigan's oil bonanza

The search is on to find pays adjacent to a Trenton-Black River trend that already has produced three promising oil fields

By Garland D. Ells and Robert E. Ives, Petroleum Geologists
Michigan Geological Survey
Lansing, Mich.

EFFORTS TO PROVE up a Trenton-Black River trend have transformed south-central Michigan into one of the hottest oil plays east of the Mississippi River.

Current development is along a narrow trend which begins about 2½ miles east of Jonesville in Hillsdale County and extends 20 miles to Albion in Calhoun County. To date, the trend includes the Scipio field where the discovery well was completed in June 1958, plus the Albion and Pulaski fields.

A new test now drilling about 5½ miles south and east of the south limits of the Scipio field looks very promising and is expected to extend the trend in that direction (Map 2).

Here is a quick look at the trend activity through September 1:

Scipio Field (Hillsdale County): 16 wells are drilling or testing, and four locations have been made. Six wildcats are either located or being drilled in the county.

During the first eight months of 1959, a total of 17 oil wells and 13 dry holes were completed in the area. This compares with 19 oil wells and 5 dry holes completed in 1958.

Albion Field (Calhoun County): Since the discovery well was completed in December 1958, a total of 19 oil wells and 5 dry holes have been completed. Seven wells were drilling on September 1, and 10 locations were staked. There are three wildcat locations in the county.

Pulaski Field (Jackson County): Since the field was discovered last January, 6 oil wells and 3 dry holes have been completed. Five wells were drilling on September 1, and 7 locations had been staked. Nine wildcats are either located or being drilled in the county.

Prospects excellent. Although exploration is both costly and hazardous in the area, the Scipio-Albion-Pulaski Trenton-Black River trend has exceptional possibilities. Most future evaluations have been based on the prospects for adjacent trends and developing the present trend.

A test being drilled in Hanover Township, Jackson County, has partially substantiated the idea of adjacent trends (Map 1). The Bissell 1 logged a good show of gas at 4,002 feet in the Trenton. Present depth of the well is 4,323 feet, and operators plan to drill an additional 100 feet.

Initial gas gages for the well were in excess of 17 MMcf. No oil had been encountered in early September.

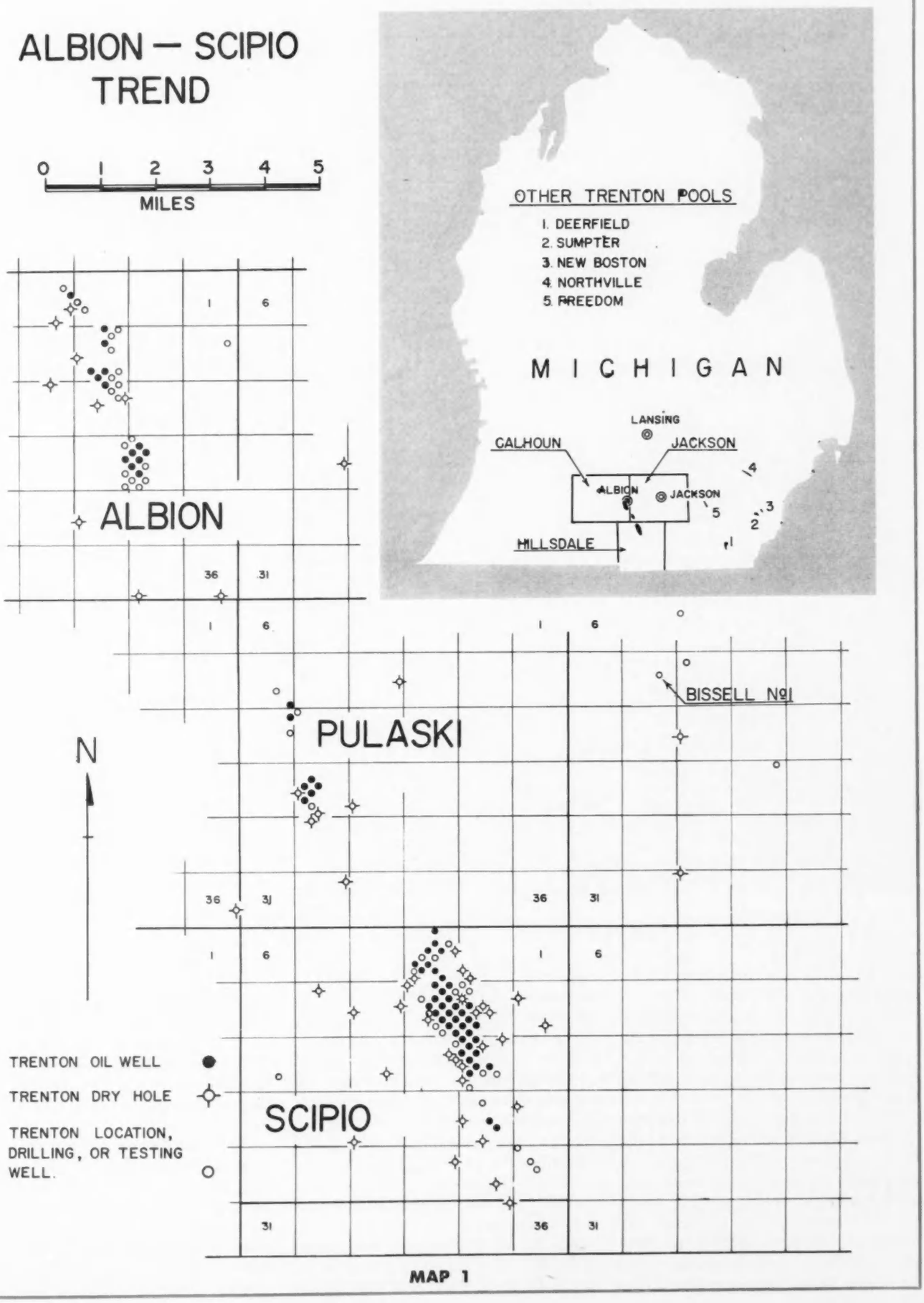
The principal portion of south-central Michigan has been leased by major companies and independents. Many drilling programs have been set up or are in the process of being made. The area looks good and has all the attributes of a typical oil boom.

The Michigan Geological Survey maintains records of the wells drilled in the state and makes them available to operators.

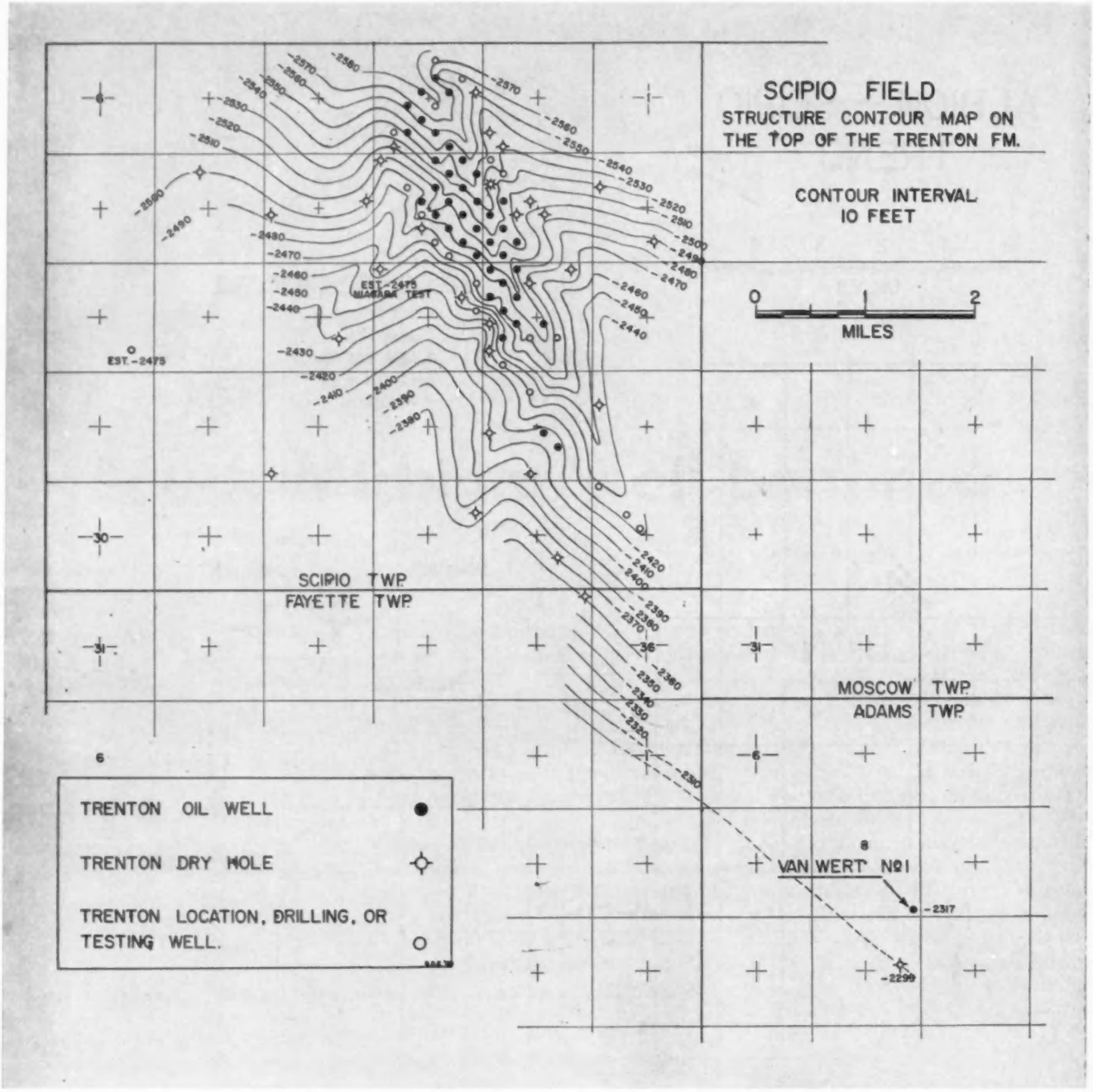
Geology. The Scipio field discovery well was a non-technical location, although a gravity survey had been conducted through the area just prior to spudding. Based on the interpretation of gravity highs, the company doing the gravity work leased acreage on the east and west sides of the discovery well property.

As a result of the leasing program and a subsequent visit to a fortune teller, property owners of the discovery well, with the help of a contractor, promoted and drilled the test.

The Albion-Scipio trend is located on the southern flank of the Michigan Basin and the various formations dip in a northerly direction. Detailed contours on the producing formations in Scipio indicate a shallow depression


ALBION — SCIPIO TREND
0 1 2 3 4 5
MILES
OTHER TRENTON POOLS
1. DEERFIELD
2. SUMPTER
3. NEW BOSTON
4. NORTHVILLE
5. FREEDOM
MICHIGAN
LANSING
CALHOUN
JACKSON
ALBION
JACKSON
HILLSDALE
ALBION
PULASKI
BISSELL No1
SCIPIO
N
TRENTON OIL WELL
TRENTON DRY HOLE
TRENTON LOCATION, DRILLING, OR TESTING WELL.

MAP 1



MAP 2

which plunges northwest (Map 2). This same pattern is exemplified in the Albion and Pulaski fields and appears to be directly associated with a fracture zone which extends in the same direction.

The oil is being produced from the Trenton-Black River formation of the Ordovician system. This formation is principally limestone throughout southern Michigan. However, in areas where fracturing has occurred, the limestone has been altered to dolomite, which is true of the south-central Michigan trend. On either side of the depression the formation is a dense limestone with very little porosity, while in and on the flanks of the depression it is a secondary dolomite.

The pay section usually consists of varying size vugs interconnected with fractures and intercrystalline porosity. As can be expected in a reservoir of this type, the pays are highly irregular depending on the degree of fracturing, resulting solution activity, and dolomitization.

Studies of the younger formations indicate that the Cataract (Figure 1) definitely reflects the Trenton flexure along the trend. Some of the younger formations such as the Traverse Limestone of Devonian age, and certain Salina beds of Silurian age, also show a slight indication of the structure (See WORLD OIL, September 1959, Page 88).

However, due to the low relief of approximately 40 feet in the depression, it is difficult to ascertain the relationship of these formations to the Trenton. In other areas of southern Michigan, such as the Freedom and Northville structures in Washtenaw County where there is a considerable

magnitude of relief, the shallower beds definitely reflect the underlying Trenton formation

Development history. Prior to discovery and development of the Scipio, Albion and Pulaski fields, the Trenton-Black River formation was not considered very productive in Michigan. Numerous Trenton tests had been drilled in southeast Michigan, and with the exception of the Northville field in Washtenaw and Wayne Counties, all were disappointing.

The Scipio field discovery well was spudded in May 1955. This test, Houseknecht 1, penetrated the Trenton at 3,563 feet. The first gas was logged at 3,650 feet in September 1956. Oil was encountered at 3,776 feet in January 1958, and the well was completed at 3,900 feet in June.

Initial gages ranged between 2.5 and 10 barrels of oil per hour and 2.5 to 5 MMcf gas per day. Tubing was run through the gas zone and the well completed, flowing 140 barrels of oil per day.

The field did not receive much attention until September 1957, when the fourth well to be drilled, Stevens 1, blew out of control for 25 hours. The well lost circulation at 3,770 feet. Operators tried to shut the well in but the surface began to crater, making it necessary to open the well.

Approximately 4,000 barrels of oil and 15 MMcf of gas were lost before the well was killed with salt water. The 5-inch casing was run and the well put on production, flowing an initial 2,410 barrels of oil per day. By the end of December 1958, 25 wells had been completed in the field. These wells produced 527,253 barrels of oil during 1958.

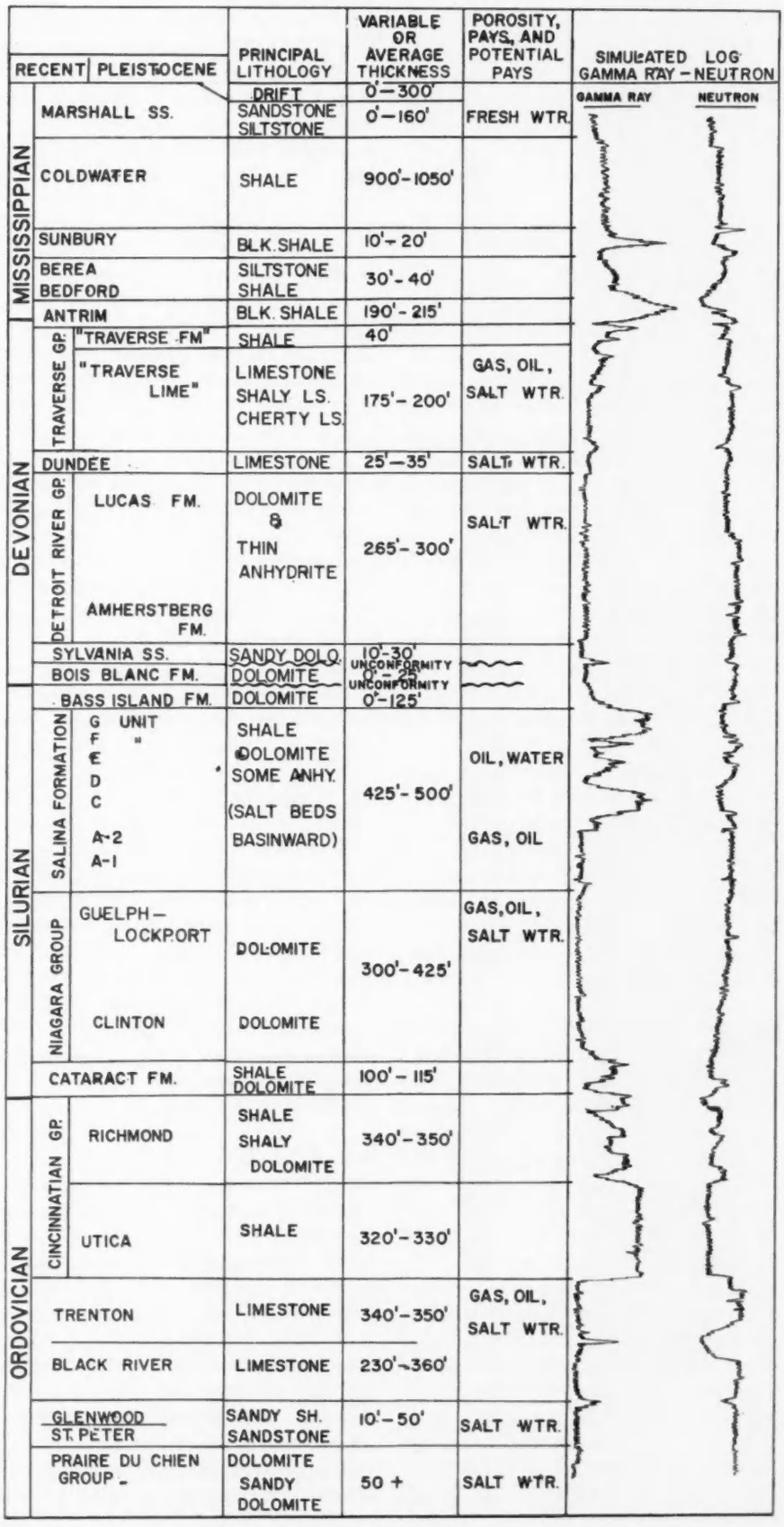
In December 1958, the Albion field was discovered about 12 miles north and west of Scipio, and aligned with that field. The discovery well, Resenau 1, was completed for an initial production of 200 barrels of oil per day from 4,324 feet.

Early in January 1959, a third discovery, the Pulaski field, was completed on the trend. The Blair 1 flowed 160 barrels of oil per day from 3,820 feet. Total depth was 3,832 feet.

Limits of the three fields have not yet been defined. Proven acreage through mid-August was 800 acres for the Scipio field, 200 acres for Albion and 120 acres for Pulaski.

In late August another potential extension to the Scipio field was re-

Stratigraphic Chart of Formations Encountered in the Scipio, Pulaski and Albion Fields



(Illustration not to scale)

FIGURE 1

ported in Adams Township of Hillsdale County. Located about 5½ miles south and east of the south limits of the field, Van Wert 1 reportedly flowed 50 barrels of oil per hour from a drill stem test at 3,959 feet.

20-acre spacing. There is a drilling unit and well spacing order in effect in all three fields. The drilling unit is a 20-acre tract formed by dividing a quarter-quarter section of land into an east half and a west half. The wells are drilled in the center of the northwest or southeast one quarter of the quarter-quarter section of land.

Several exceptions to the above well spacing have recently been made. These were located on the edges of the Scipio field and near dry holes. Since the Scipio, Albion and Pulaski fields also have production proration, any well drilled as an exception to the drilling unit and spacing regulation is prorated accordingly.

The Ohio Oil Company became one of the major acreage holders in southern Michigan with the recent acquisition of the Aurora Gasoline Company. Ohio, McClure and Clifford Perry, now control the bulk of the acreage in and around the Scipio field.

For the most part, the other operators in the field are drilling on farmout acreage. The Carter Oil Company, The Ohio Oil Company, Sun Oil Company, and McClure Drilling Company are the biggest lease holders on the north part of the trend. Numerous independents also hold substantial acreage in this area.

Reserve estimates. New wells are constantly being added to the fields along the trend. Consequently, the daily production is being changed significantly every month. Estimated daily production as of September 1 is as follows: Albion, 14 wells, 1,100 barrels of oil; Pulaski, 7 wells, 560 barrels of oil; Scipio, 40 wells, 4,720 barrels of oil.

It is still too early in the productive history of the fields to establish a reservoir pressure trend. The original bottom hole pressure for the Scipio field was approximately 1,600 pounds and for Albion 1,800 pounds.

Recoverable reserve estimates have been rather large for the three fields now in the trend. This can be attributed to the nature of the reservoir. The primary reservoir energy source is a gas cap and gas solution drive. However, there also has been an indication of a bottom hole water drive.

The variable nature of the pays, questionable effectiveness of the water drive energy, and the undefined limits to the fields, make it very difficult to calculate any reliable reserve figures. On the basis of individual well performance, it is expected that the primary recovery per acre, if the fields continue to be produced as they are now, should be between 7,000 and 10,000 barrels of oil.

Drilling operations. Practically all development wells along the trend are being drilled with rotary tools. Wildcat wells in the general area have been drilled by various methods, including straight cable tool, straight rotary or combination of each.

In respect to the combination drilling, operators usually rotary to the top of the Trenton and then tail in with cable tools. This method was tried in the field wells. However, a major gas cap and resulting pressures have caused most of the operators to switch to straight rotary drilling.

The basic casing requirements set up by the Conservation Department for rotary holes drilled in Jackson, Hillsdale, Calhoun, and Branch counties is to set 10-inch through the glacial drift and Marshall to about 550 feet and cement to the surface.

The long string is left more or less to the discretion of the operator. It may be run into the Trenton below the gas-oil contact or at the total depth and cemented. If it is run below the gas-oil contact, operators drill the rest of the hole with cable tools. This program was established to minimize the danger caused by blow-outs and lost circulation zones.

The average length of time to drill a Trenton test in the area is 15 to 20 days for a 4,000-foot hole. However, this depends a great deal upon the trouble encountered while drilling the Trenton.

The operators usually use about 8-pound mud. Both conventional and jet bits have been used in the drilling.

Drilling costs have varied considerably in some of the tests. However, average costs are about $30,000 for a dry hole and $50,000 on completion wells.

Prior to completing the wells, most of the operators are running gamma ray-neutron logs. Where casing has been set at the total depth, they perforate the prospective pay zone and treat with about 500 gallons of mud cleaning acid. If the well does not respond properly, they may treat it with regular acid or by sandfracturing.

In the case of sandfracturing, extreme caution should be taken as there is a good possibility that the well might be fractured into the overlying gas zone. Plunger lifts are then installed to prevent the excess accumulation of paraffins in the tubing and the well put on production.

Production data. Presently, the Scipio, Pulaski and Albion fields are prorated at 150 barrels of oil per day and/or 200 Mcf of gas. This order is issued on the basis of gas-oil ratio tests.

Most of the wells are flowing on a plunger lift. The large gas cap present has caused some difficulty in completing the wells properly. Operators have adjusted to this in the Scipio and Pulaski fields, where most of the wells are being completed with gas-oil ratios of less than 600 cubic feet per barrel of oil.

However, considerable trouble has been encountered in the Albion field. Excess gas-oil ratios have made it necessary to prorate several of the wells to less than 50 barrel of oil per day.

Gas-oil separators and heater treaters are being used in the fields. A few of the wells are making some water. This is being disposed of into special brine disposal wells or into the annular space between casings. The Traverse and Niagara are the two main formations being utilized for brine disposal. Tankage is set up relative to the lease with one battery handling several wells in some cases.

The oil is about 42 gravity. It is paraffin base and has little or no sulfur. The gas is about 62 percent methane, 22 percent nitrogen, and combined 9 percent of ethane and propane, and small amounts of other gas constituents.

The gas is about 853 Btu according to one analysis.

Price per barrel of oil is approximately $2.96 at the well head. All oil is being transported by truck and the excess gas is flared on location. The Ohio Oil Company has applied for permission from the state to build an 8-inch pipe line from the Scipio field southeast about 60 miles to the Buckeye pipe line terminal in Bedford Township, Monroe County.—**The End**

How through-tubing bridge plugs work

New tool permits low cost up-hole recompletion of wells as deep as 11,000 feet. Jobs require only 24-30 hours, and all work including cementing is performed without pulling pipe or packer

By Robert W. Scott
Engineering Editor, WORLD OIL

THE DRILLABLE through-tubing bridge plug promises to be a valuable contribution to permanent type completion work. Plug back operations have been accomplished through tubing as small as 1½-inch with a minimum of equipment and at relatively low cost. Plugs have been set successfully in wells below 11,000 feet and lower zones of multiple pay wells have been recompleted without disturbing upper completions. Chief advantages of the procedure are:

- Economical
- Lower zones of multiple completions can be plugged back without shutting in or killing upper producing zones
- There is no risk of cementing or "plugging" a string of tubing or extension pipe due to flash setting of cement
- No special down hole equipment is required—only a full open tubing string
- Plug back jobs are completed, the well re-perforated and restored to production in a minimum of time
- No rig or pumping equipment is required
- The method is applicable to wells which previously have been set up for permanent completion work. Of course, as with conventional PTC wells, the tubing must be set above the new zone of interest
- Plugs are drillable
- Equipment required to set the plugs also can be used for logging, perforating, etc.

The trend toward reduced well remedial costs as evidenced by past introduction of wireline PTC equipment and concentric tubing workover methods has been further advanced by development of the through-tubing bridge plug. Now it is possible to complete plug back jobs as deep as 11,000 feet in a 24-30 hour period. This includes setting the plug and perforating a new zone.

The procedure consists of running a plug through the tubing string and out into the casing in a collapsed position. It should be pointed out that the bridge plug itself does not effect a seal, but serves only as a stop or retainer for sealing materials such as cement or plastic. When a predetermined setting point is reached, the plug is expanded and set firmly in the casing, providing a base for cement or plastic slurry which is spotted by dump bailer. After the sealing material hardens, the well may be reperforated up-the-hole in a new zone.

Field experience has indicated that if careful attention is given prepara-

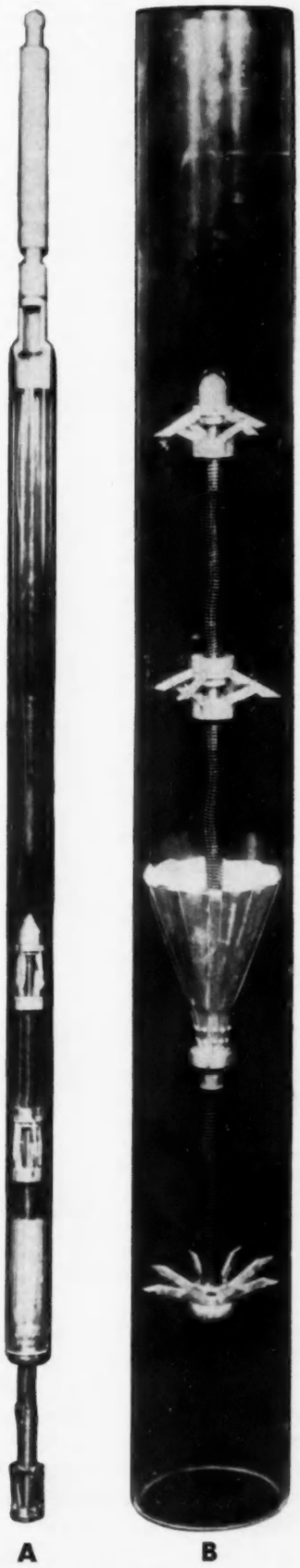


FIGURE 1—Three sets of dogs are used to prevent plug Type A from moving up or down hole. The metal petal basket acts as a stop for cement slurry deposited on top of the plug by dump bailer. Figure 1A shows plug in running position. Dogs and basket are expanded in the casing and the tool is ready to receive cement in Figure 1B.

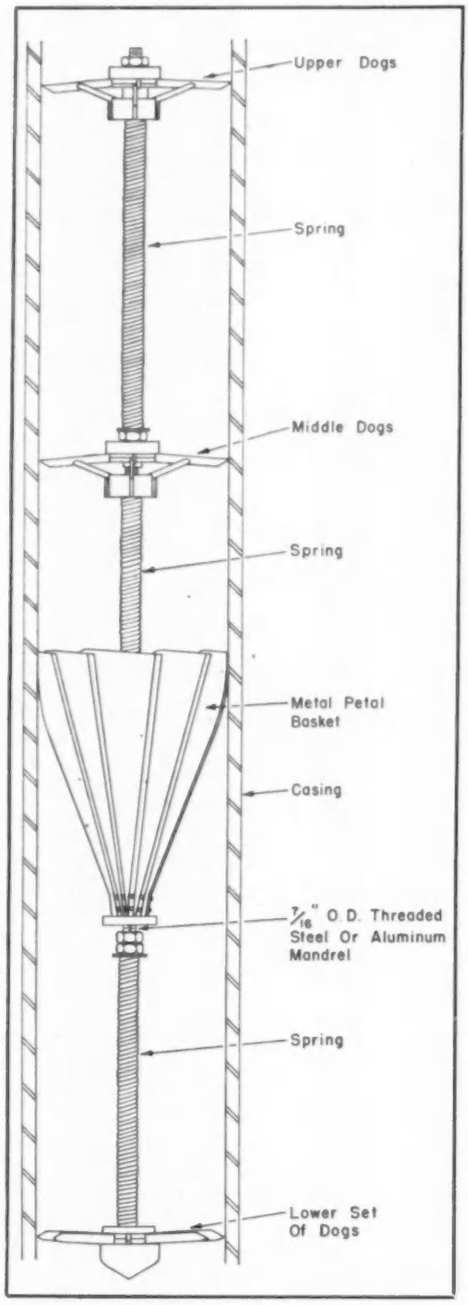


FIGURE 2—Details of the metal petal basket type of through-tubing bridge plug (Type A).

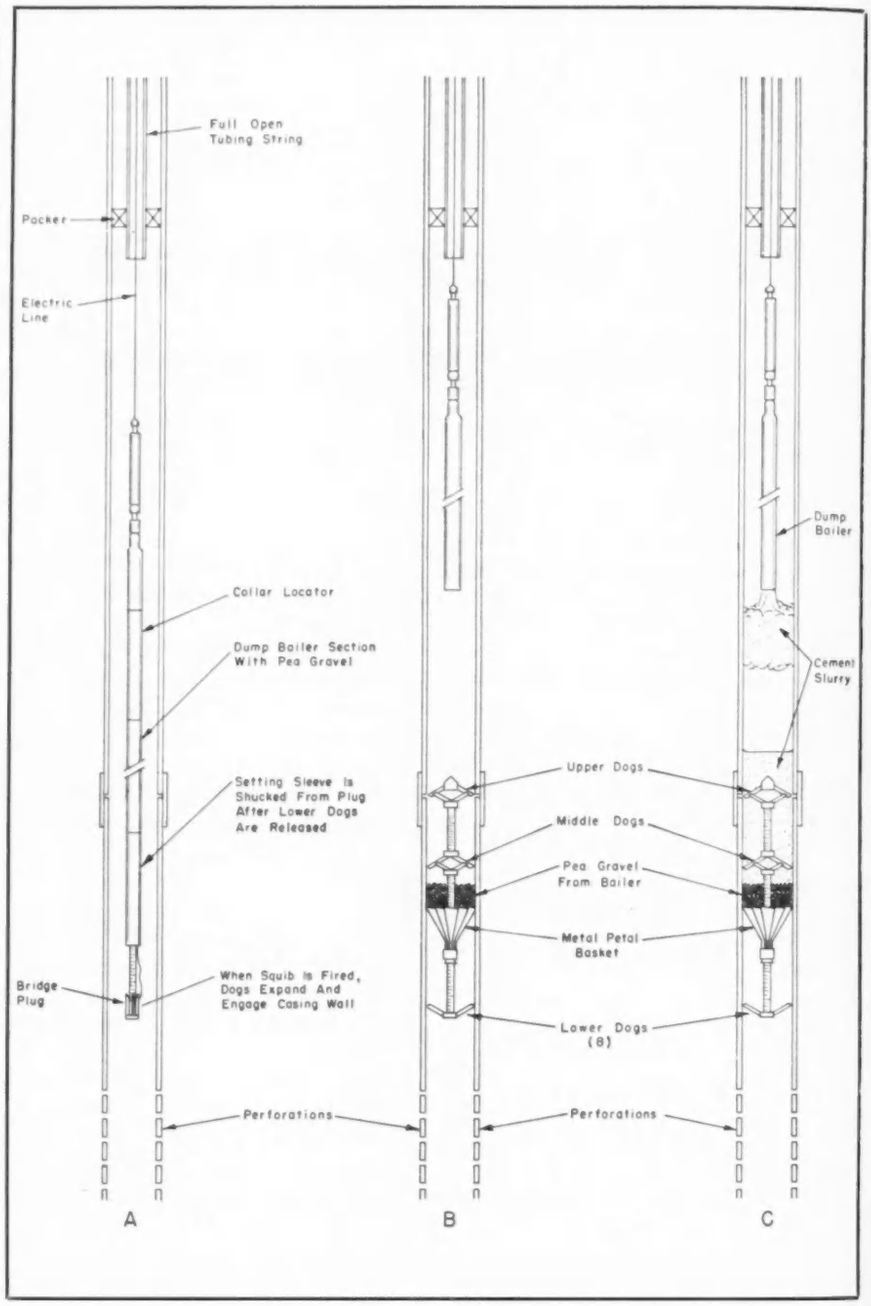


FIGURE 3—This running and setting sequence is normally employed when using Type plug A. The spring loaded lower dogs are held in a closed position by 1/32-inch wire to which a surface activated electric charge is attached. The lower dogs expand when the charge is detonated. After the plug has attained a sufficient set, a tubing gun is used to perforate the new zone of interest.

tion of the cement slurry and the manner in which it is dumped, a 10 foot plug allowed to set 48 hours in 5½-inch casing usually will withstand a differential pressure of 3,000 psi. If cement is spotted in old perforations or a casing collar, plug strength is increased.

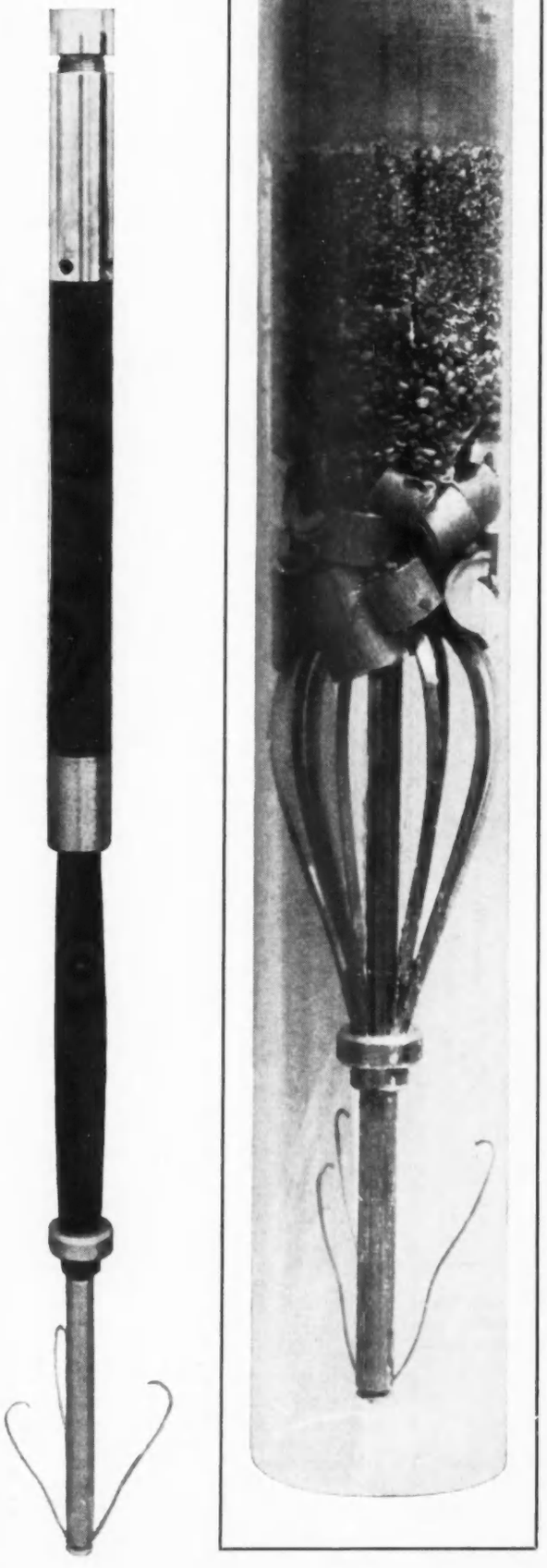
Types. At present, four different types of through-tubing bridge plugs are available commercially. For convenience, they will be referred to in this article as follows:

Plug	Type "Stop" Provided For Cement
Type A . . .	Metal petal basket (Figure 1)
Type B . . .	Aluminum junk rings on "ribbed" cage (Figure 4)
Type C . . .	"Sponge" basket (Figure 7)
Type D . . .	Neoprene impregnated nylon basket (Figure 10)

Although all plugs were designed for essentially the same purpose, each is different in construction and method of placement in the well bore.

In general, all operators follow the same procedure prior to running the bridge plug itself. Usually, a gage run is made with a collar locator and an empty section or sections of dump bailer. A collar log is recorded for accuracy. Also, a through-tubing gamma ray survey may be run if desired.

Dump bailers are used to deposit cement or plastic on top of the bridg-



A B

FIGURE 4 (left)—Plug Type B is installed in the casing by a propellant activated tool. As a charge in the setting tool is fired, the mandrel of the plug is forced upward and the adjustment sleeve is forced downward. The ribs attached to the adjustable sleeve are forced outward and obtain a tight friction hold within the casing. The interlocking aluminum junk rings fall on top of the expanded rib section and form a sufficient base for cement slurry. Figure 4A shows the tool as run in the well. Figure 4B shows the plug set and cemented.

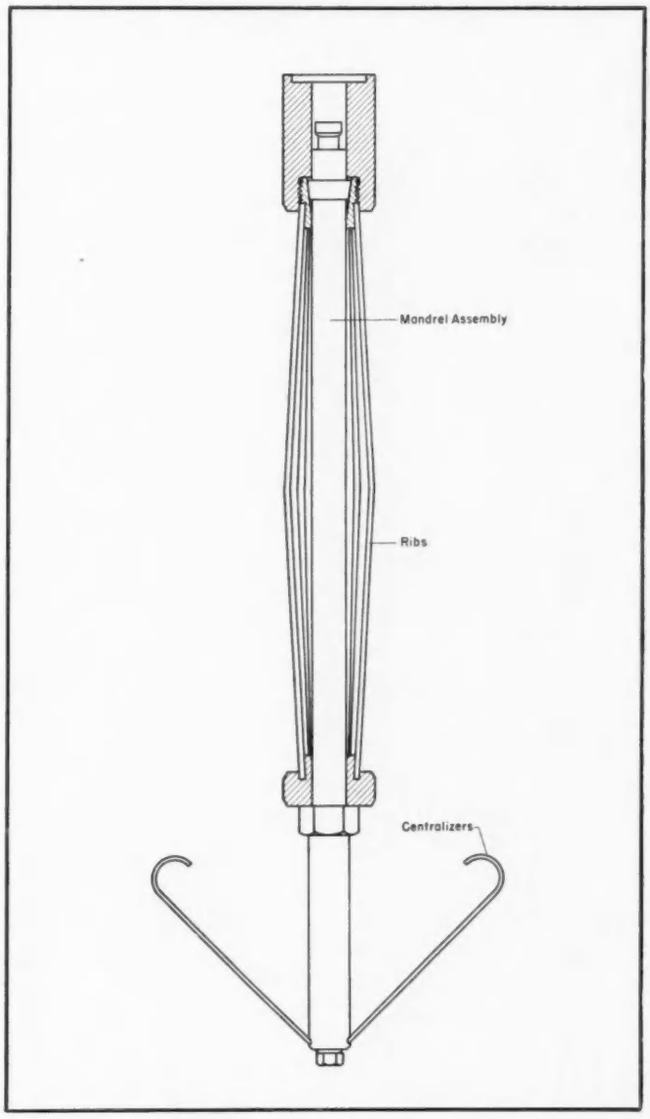


FIGURE 5—Plug Type B as run in the hole. Interlocking aluminum junk rings are mounted above the top portion of the plug assembly.

ing devices after they are set in the well bore. All bailers are activated by an electric blasting cap for positive control.

Plug Type A. The plug designated as Type A consists of a 7/16-inch OD threaded steel or aluminum mandrel, a spring steel metal petal basket and three sets of spring loaded retaining dogs (Figures 1 and 2). The lower set of dogs prevents the plug from moving up-the-hole and the middle and upper sets prevent it from moving down-hole. Variations of this design using two metal baskets and with dogs in different positions on the mandrel also have worked successfully.

The top two-thirds of the plug, with upper dogs and basket collapsed, is inserted into the running tool which

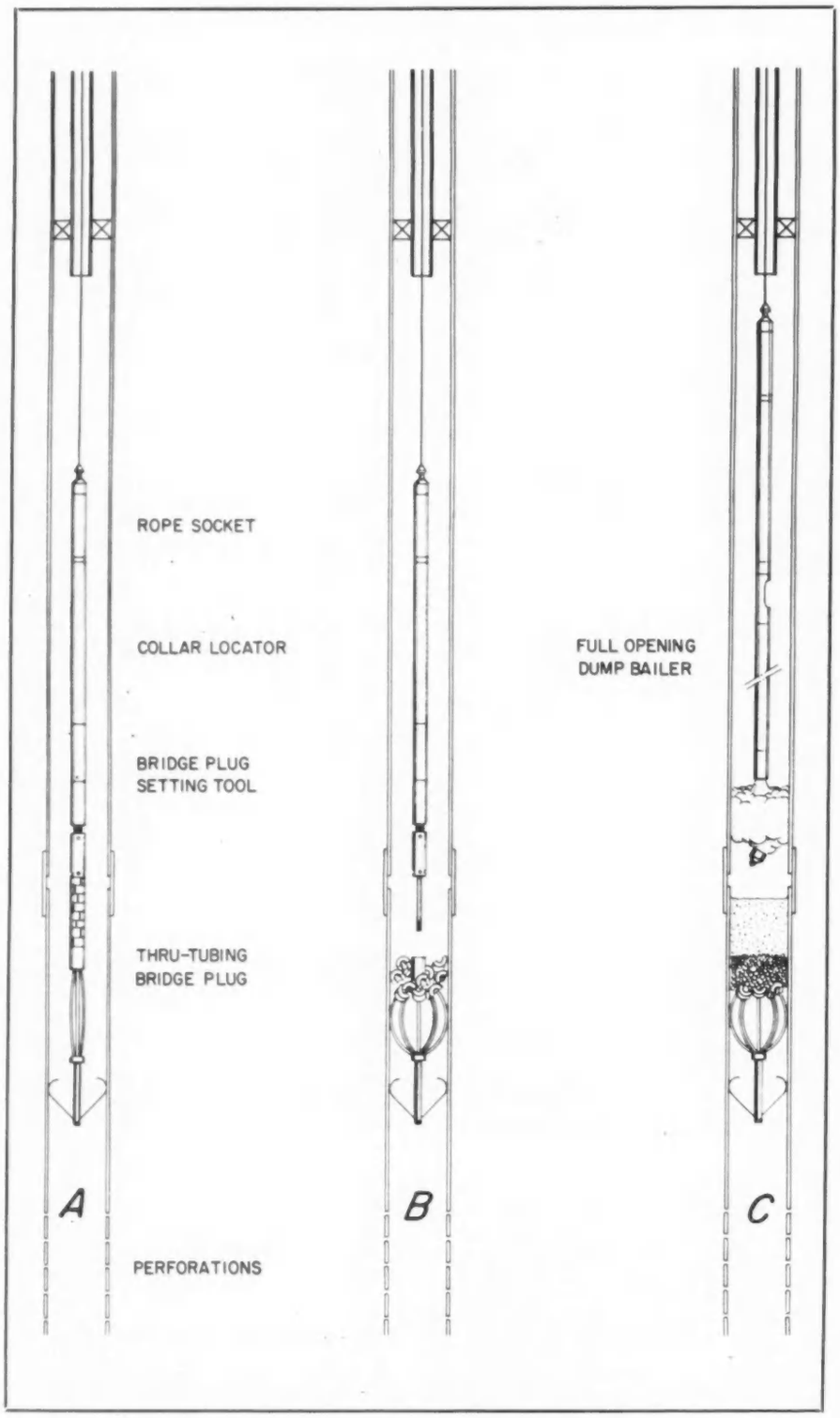


FIGURE 6—The rib-type plug is installed by means of a special running tool. When the tool is fired, the aluminum junk rings fall on top of the rig cage assembly and form a base for the cement slurry. For strength, it is desirable to spot the plug in a casing collar or old perforations.

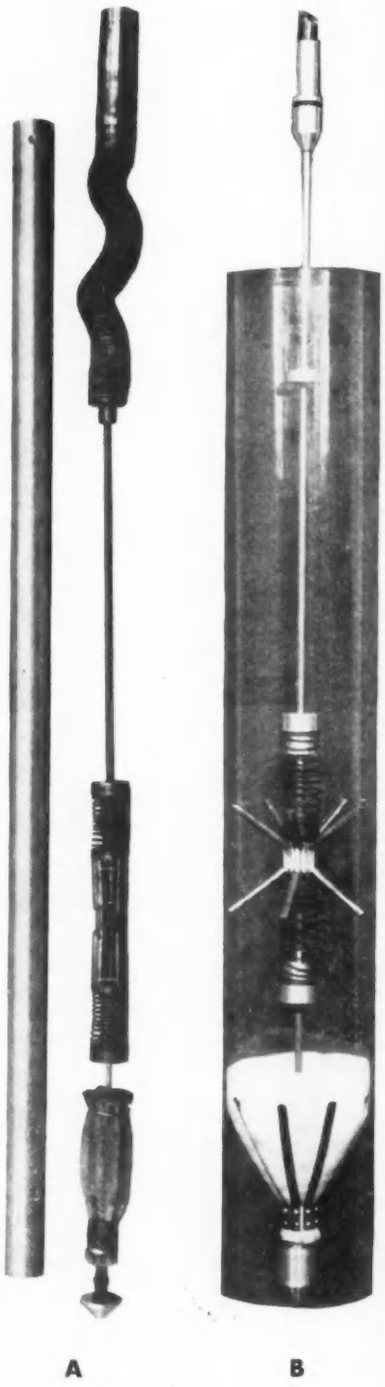


FIGURE 7—Plug Type C which employs a "sponge" basket as a cement stop is run completely encased in an aluminum running tube. The plug is spring-ejected once a plastic release plug is shattered by a blasting cap. Figure 7A shows the plug in running position but not encased in the aluminum tube. The plug is set in casing as shown in 7B. Note the shattered plastic release plug on top of the set bridge plug.

is a simple retaining sleeve. The lower set of dogs, which remains exposed (it is not contained in the running tool), also is retracted and held in place parallel to the mandrel by a 1/32-inch cable to which an electric charge has been attached. If desired, a section of dump bailer filled with pea gravel can be run immediately above the setting sleeve.

After positioning the plug at the desired depth, the electric squib is

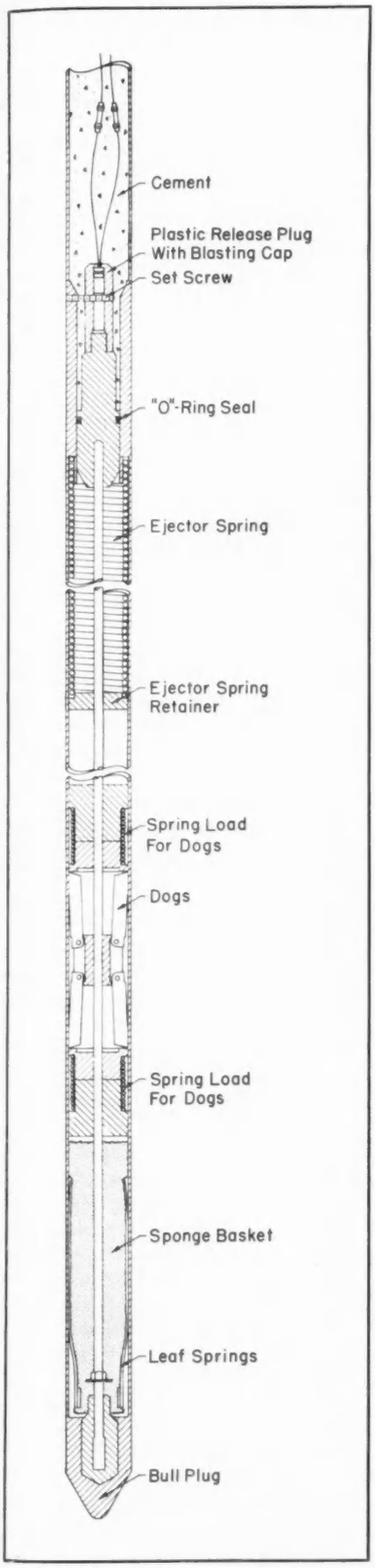


FIGURE 8—Here is a schematic drawing of the sponge basket type of plug (Type C).

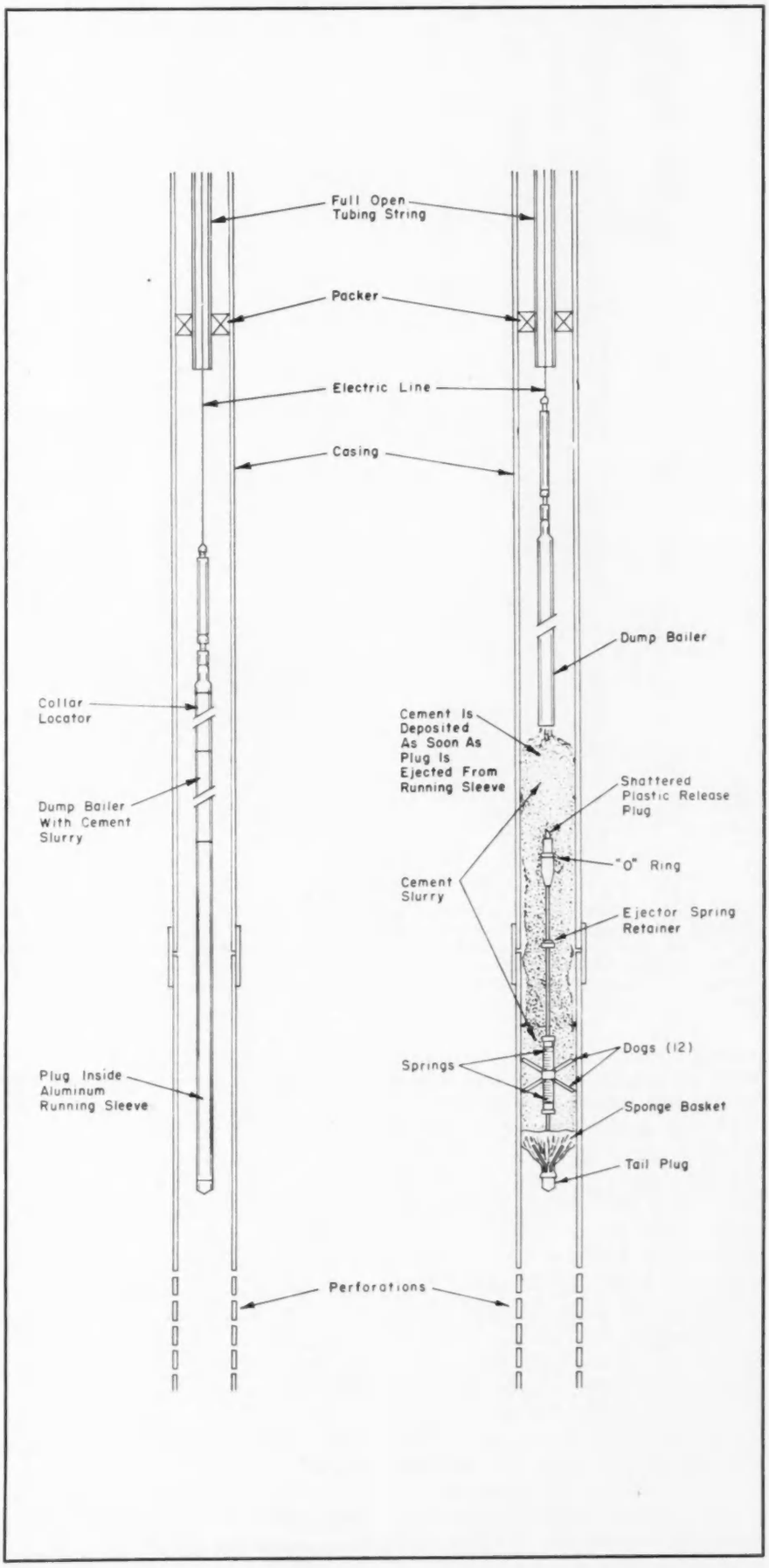
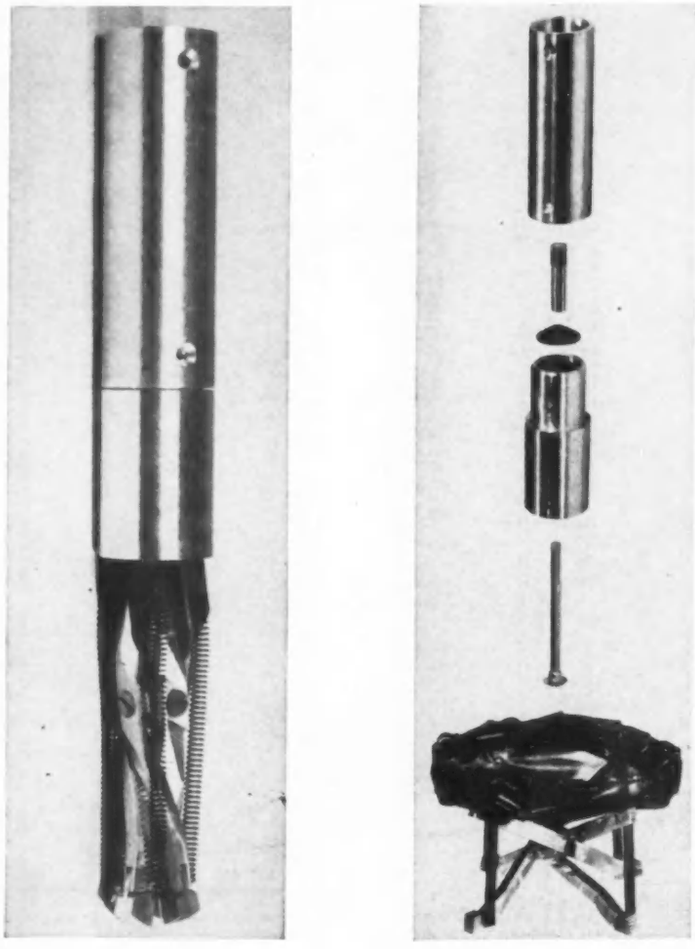


FIGURE 9—As the sponge basket type plug is ejected from its running tube, dogs expand and seat in the casing wall. Also, an O-ring seal is broken and cement is deposited as the plug is ejected.



A B

FIGURE 10—Plug Type D consists of a framework of four spring loaded aluminum legs and a neoprene impregnated nylon basket which provides a stop for the cement. In Figure 10A, the tool is ready to run in the hole. Figure 10B shows an exploded view of the running assembly. The top aluminum sleeve is attached to the dump bailer bottom. The "rolling" dogs on the end of each leg tend to set the plug more firmly in the casing as cement is dumped.

fired, releasing the lower set of spring loaded dogs which expands and engages the wall of the casing. Tools then are picked up to shuck the running sleeve from the upper part of the plug. Since this upper portion fits snugly inside the running sleeve, this upward pull tends to set the lower dogs more firmly into the casing well. As the running sleeve is shucked from the plug, the metal petal basket and top sets of spring loaded dogs are released and expand within the limits of the I.D. of the casing. The pea gravel contained in the bailer then will fall onto the basket. The operator, thus is assured that the basket is open and will provide a sufficient base for the plugging material.

Running tools then are slacked off onto the upper set of dogs. This tends to firmly set the upper and middle sets of dogs which prevent down hole movement. In case of necessity, the running tools are heavy enough to knock the plug free and on down the hole.

A through-tubing dump bailer is employed to spot cement to a desired height on top of the plug. Normally a 10-foot plug is used (Figure 3). The well then is shut in and cement allowed to set. If desired, the plug can be pressure tested after cement has hardened to insure a good job.

The well then can be re-perforated through tubing and recompleted in the new zone.

Plug Type B. The second type of through-tubing bridge plug is constructed entirely of aluminum. The plug consists of a main tension mandrel, a set of "ribs" which are attached to a propellant actuated sleeve, a number of interlocking aluminum junk rings and a centralizer arrangement (Figures 4 and 5). The same general procedure is used prior to running this plug as the one described previously. However, the actual setting procedure is different.

The ribbed type of plug is run on a special setting tool. The friction ribs are collapsed and held in place along the body of the plug. A number of interlocking aluminum junk rings are added to the mandrel above the collapsed ribs, and the entire assembly made up on the running tool.

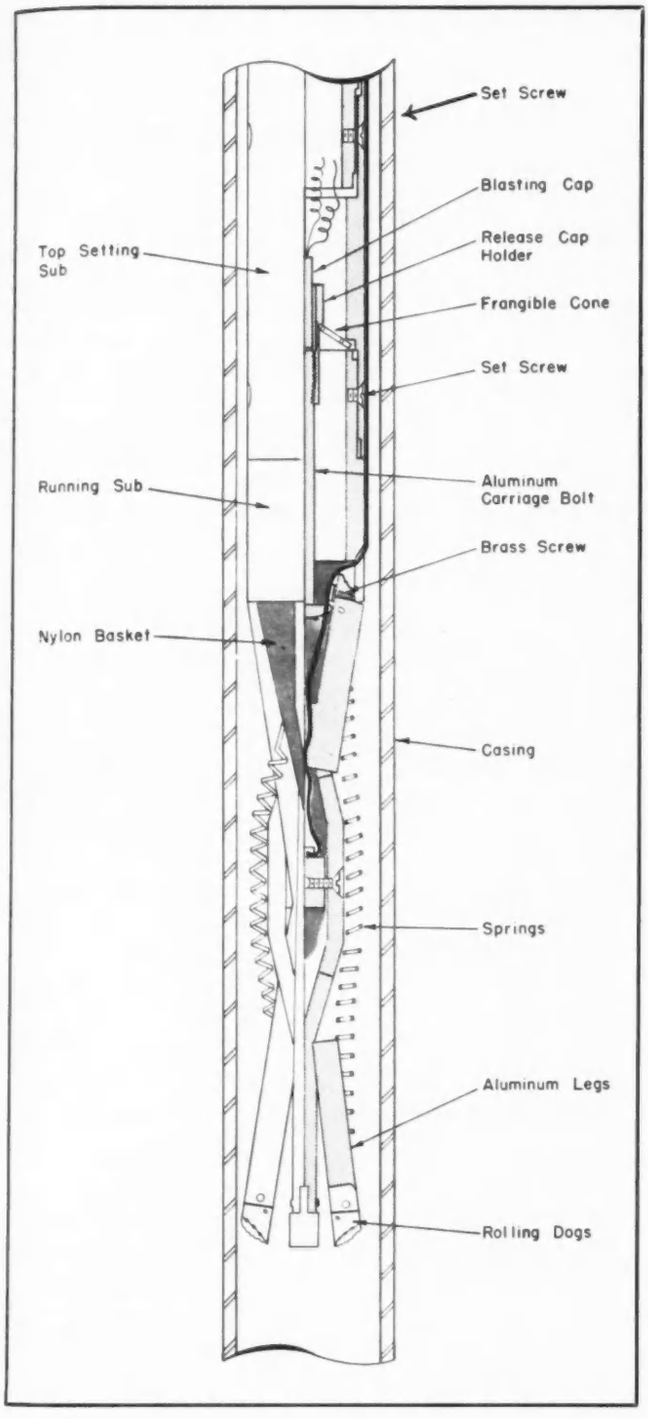
After reaching the correct setting depth, a propellant in the setting tool is ignited from surface by means of the electric line. The propellant drives the adjustment sleeve (to which the ribs are attached) downward, simultaneously pulling the plug mandrel upward. As the adjustment sleeve moves downward, a locking device is engaged and secures the sleeve to the mandrel body. This, in turn, causes the ribs to expand and obtain a tight friction hold against the wall of the casing. As the pulling tool is released automatically and picked up, the interlocked aluminum junk rings described previously fall free and come to rest on top of the plug. They serve to form a bridge sufficient to support the slurry material.

In addition, gravel and sand may be run in the dump bailer previous to running cement. This will assure a proper base for the cement column. A dump bailer is used to spot the desired quantity of cement, and the well is re-completed in the same way as described previously (Figure 6).

Plug Type C. The third type of plug consists of a center rod assembly, an ejection piston, an ejector spring retainer, two sets of spring loaded dogs, a "sponge" type basket supported by leaf springs and a tail plug. Complete detail is shown in Figures 7 and 8.

This type of plug is run completely encased in an aluminum tube, and is not exposed to the interior of the well until set. The aluminum tube is attached to an ejector spring equipped adapter sub which, in turn, is run on the dump bailer bottom.

A plastic release plug containing an electric blasting cap is screwed onto the topmost connection of the bridge plug. Dogs, basket, etc., are collapsed and the plug is inserted into the aluminum running tube. A retainer on



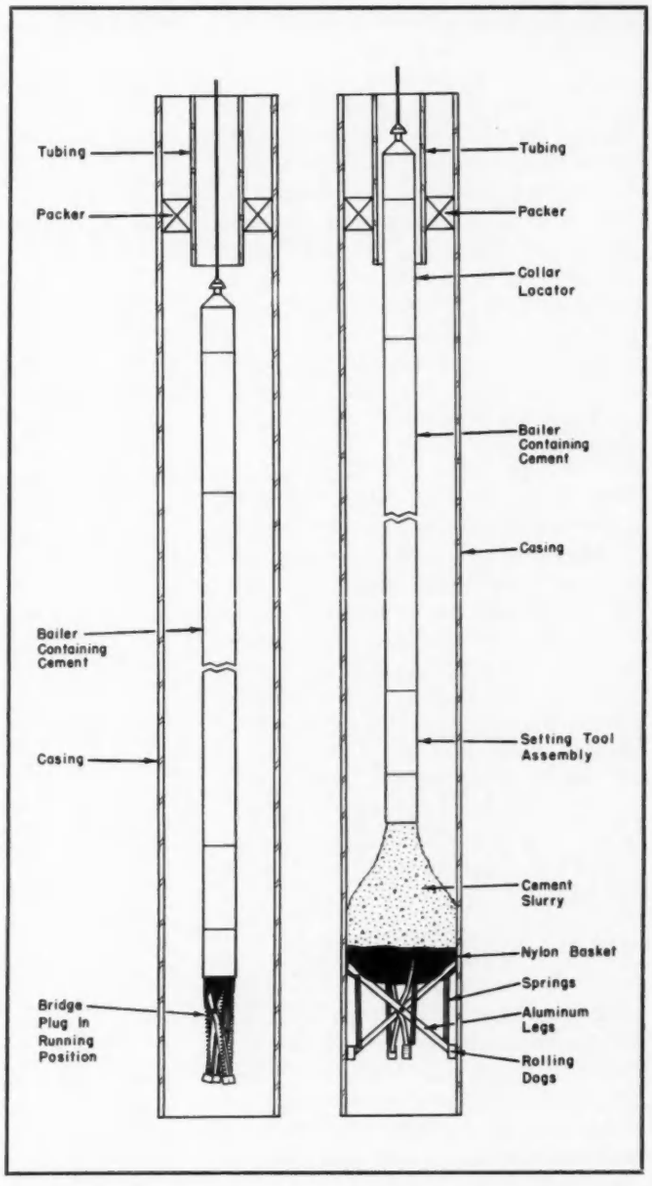


FIGURE 12—When plug Type D has been positioned properly in the hole, a squib is fired and the tool is ejected. When the frangible cone in the running assembly shatters, cement is released and deposited on the plug as it is set.

FIGURE 11 (left)—This engineering drawing of plug Type D shows details of the running assembly.

the upper portion of the center rod assembly compresses the ejector spring which extends into the aluminum tube from the adapter sub. After collapsing the spring, a set screw is passed through the adapter sub and plastic release plug attaching the bridge plug to the adapter sub. The squib then is connected to the firing cable which extends through the dump bailer.

As shown in Figure 8, an O-ring on the ejection piston (attached to the uppermost part of the bridge plug) provides a seal between well fluid and the interior of the dump bailer.

To set the plug, an initial gage run, gamma ray survey, collar log, etc., is conducted as before. The bridge plug attached to the running tool then is secured to the botom of the dump bailer. Cement is mixed and the bailer is filled with the O-ring seal mentioned previously, preventing cement leakage from the bailer.

The plug is run in the hole, positioned at the proper depth and the squib contained in the plastic release plug is fired. This shatters the plastic release plug (Figures 7 and 8) and allows the ejector spring to act against the retainer on the bridge plug rod assembly. Since the bridge plug no longer is held in position by the plastic release plug, it is ejected from the aluminum tube by the compressed ejector spring.

As the plug falls free of the aluminum running tube, the sponge basket is released into the open position and the spring loaded dogs (which prevent up-or-down-hole movement) ex-

pand and engage the wall of the casing. Simultaneously, the O-ring seal between the bridge plug and the cement in the dump bailer is broken since it is contained on the ejected bridge plug. Because the seal no longer retains slurry in the dump bailer, cement is deposited on top of the plug (Figure 9). Actually, the plug is set and cement is placed in position at the same time. If more cement is desired, the dump bailer is provided with a different bottom and additional runs are made. This plug has been used on a number of jobs, several of which are listed in Table 3.

Plug Type D. This plug consists of a framework of four aluminum legs which are attached by brass screws to a center aluminum block. Legs are spaced 90 degrees around the block. A basket, or diaphragm, of neoprene impregnated nylon is attached by screws to the legs and center block. Spring loads are incorporated which tend to hold the legs of the plug in an extended or maximum diameter position (Figures 10 and 11). The end of each leg is equipped with a pivoted foot which tends to "roll" and wedge the bridge plug tighter in the casing as cement is applied.

To prepare the plug for running, it first is collapsed around an aluminum carriage bolt (expanding the springs attached to the legs). The head of the carriage bolt locks under the brass screw heads which hold the diaphragm to the legs. The collapsed tool and carriage bolt are inserted into an aluminum running sub with the bolt extending from the top of the running tool. A frangible cone is slipped over the bolt as indicated in Figure 10. A release cap holder (containing a blasting cap) is screwed over the bolt and serves to hold the entire assembly together.

The running sub with plug, etc., then is attached to the bottom of the dump bailer. Cement is mixed and the bailer filled, with the plug assembly at the bottom serving as a seal for the slurry.

The tool is run through the tubing and positioned at the proper point in the casing. When the electric squib is fired, the frangible cap is shattered and the force of the shock on the end of the carriage bolt ejects the bridge plug from the aluminum running sub.

As the bridge is ejected, the spring loaded legs and nylon diaphragm expand. The pivoted foot on each leg engages the casing wall. As cement is deposited, these "feet" pivot and serve to seat the bridge plug even more firmly in the casing. As the frangible plug is shattered, cement is released from the bailer and immediately follows the plug from the running tool (Figure 12).

Equipment. Detailed drawings of the four types of plugs are shown in Figures 2, 5, 8 and 11. In addition, conventional electric wireline surface equipment is required. If the well must be worked over under pressure, a high pressure wireline blowout preventer and lubricator assembly also are used. Some operators, however, feel that the well should be killed prior to the plug back operation. Generally, this will depend upon individ-

TABLE 1—Jobs Performed With Type A Through Tubing Bridge Plugs

Well	Casing Size	Tubing Size	Set Plug @	Approx. Height Cement Column
1	5½	2⅜	8,725	5
2	7	2⅞	1,770	..
3	7	2⅞	3,796	10
4	7	2⅞	2,972	10
5	5½	2⅜	7,120	9
6	5	2⅜	5,097	2 Sacks Sand
7	5½	2⅜	2,889	10
8	7	2⅞	5,113	15
9	5½	2⅜	4,844	10
10	5½	2⅜	7,835	26
11	7	2⅞	10,208	10
12	8⅝	2⅜	3,930	10
13	5½	2⅜	4,824	10
14	7	2⅞	4,364	10
15	5½	2⅜	2,889	10
16	7	2⅞	8,961	10
17	7	2⅞	7,190	10
18	7	2⅞	10,210	10
19	7	2⅞	10,050	10
20	7	2⅞	1,962	10

TABLE 2—Jobs Performed With Type B Through Tubing Bridge Plugs

Well	Casing Size	Tubing Size	Set Plug @	Approx. Height (Ft) Cement Column	Time (Hrs) Required To Complete Plug Back	Elapsed Time (Hrs) To Plug Test	Differential Test On Plug (PSI)	Remarks
1	5½	2⅜	9,435	4.0	7	....	1,500	3 plugs set, 4 zones tested.
2	5½	2⅜	10,938	9.0	....	....	4,000	.....
3	5½	2⅜	8,994	8.0	13½	28	3,000	Water job
4	7	2⅞	9,109	13.5	....	....	1,200	.....
5	5	2⅜	8,892	10.0	8½	21	....	Water job
6	7	2⅜	9,475	18.0	13½	26	3,000	.....
7	7	2⅞	7,471	8.0	9	21	....	Water job
8	7	2⅞	10,075	5.0	12½	....	4,300	Water-land job
9	5½	2⅞	8,684	10.0	10½	26	3,300	.....
10	5½	2⅜	9,024	10.0	7	19	....	Water job
11	5½	2⅜	9,225	9.0	6	13½	1,600	.....
12	5½	2⅜	10,978	9.0	7	23	....	.....
13	5½	2⅜	5,632	4.0	5½	20	3,500	.....
14	5½	2⅜	5,742	8.0	6	....	....	.....
15	5½	2⅜	9,186	7.0	7½	17	....	.....
16	7	2⅜	11,310	11.0	8	22½	2,500	.....
17	7	2⅞	7,865	6.0	7	24	1,800	Water-land job
18	5½	2⅜	2,555	2.0	2½	12	....	.....
19	5½	2⅜	8,067	15.0	6	....	....	Water job
20	4½	2⅜	6,402	11.0	9	12½	3,000	.....

TABLE 3—Jobs Performed With Type C Through Tubing Bridge Plugs

Well	Casing Size	Tubing Size	Set Plug @	Approx. Height Cement Column	Test On Plug (PSI)	B.H.P.	Remarks
1	5½	2⅜	5,477	15.0	*1100	1800	Formation was taking fluid, not static conditions.
2	5½	2⅜	9,863	10.0	....	2800	.....
3	5½	2⅜	10,946	18.0	*2000	3200	Fluid level @ 4600'
4	5½	2⅜	7,253	15.0	....	1500	Fmn. taking fluid @ rate of 15 gal/min.

* Pump Pressure.

TABLE 4—Jobs Performed With Type D Through Tubing Bridge Plugs

Well	Casing Size	Tubing Size	Setting Depth (Ft)	Approx. Height (Ft) Cement Column	Time (in hours) For Plug Back	Elapsed Time (Hrs) To Test	Differential Pressure Test (PSI)	Remarks
1	5½	2	3,680	9	4½	24	....	No pressure test
2	5½	2	3,630	9	4	24	....	No pressure test
3	5½	2	5,630	9	5½	12	....	No pressure test
4	5½	2	6,815	9	6½	24	....	No pressure test
5	5½	2	3,512	20	9	12	1000	.....
6	5½	2	8,605	9	7½	24	....	No pressure test
7	5½	2	8,030	9	7	24	1000	.....
8	5½	2	6,040	6	4½	18	....	No pressure test
9	7	2½	9,570	12	17	12	1500	.....
10	5½	2	11,355	15	14	24	2000	.....
11	7	2½	8,320	9	9½	12	....	No pressure test
12	5½	2	4,190	9	5	24	....	No pressure test
13	7	2½	6,030	9	8½	24	....	No pressure test
14	5½	2	6,880	9	9½	24	....	No pressure test
15	5½	2	3,720	6	3½	12	....	No pressure test
16	5½	2	8,420	9	9	24	....	No pressure test

ual preference and company regulations.

Another unique feature of the technique is that all services (gage run, collar log, gamma ray survey, cement preparation, plug setting,, perforating etc.) can be performed by the same service unit. Possible downtime due to waiting on service trucks is eliminated.

Cement is mixed on location with an electric mixer. Since small cement volumes are used, the slurry can be controlled exactly and prepared to precise specifications. Depending upon operator preference, slurry weight may vary from 13 to 16 pounds per gallon. Slow-set cement usually is used.

Field experience. Tables 1-4 contain pertinent data from a number of through-tubing bridge plug jobs. The type plug used for each group of jobs is indicated on the appropriate table. As indicated by the tables, the technique is both mechanically and economically successful at depths from approximately 1,700 to 11,300 feet.

Other applications. If desired, a pump truck may be used in conjunction with the through-tubing bridge plug method to provide a bradenhead squeeze. In this case, the plug would be set below the perforations to be abandoned. After depositing a sufficient quantity of cement on the plug to cover the perforations, the well would be pressured up and cement squeezed into the formation. Additional cement then could be added to the slurry column remaining in the casing to cover any perforations which might be "open."

Work has been done toward perfecting a mechanical setting device for the plugs. If found feasible, bridge plugs could be set by conventional wireline trucks using 0.092 and larger wirelines. Field data is not now available on this procedure.

In several instances, wells have been re-completed without actually setting a bridge plug. These jobs involved wells which had sanded up prior to the plug-back operation. In these cases, (where sand was above the open perforations) cement was deposited by dump bailer on top of the sand column. Results were satisfactory. —**The End**

Letter to the editor cites . . .

"An awareness of industry problems . . ."

Sir:

Your thoughtful editorial in the August 1 issue of WORLD OIL entitled "Let's Not Sit Idly By" reflects an awareness of industry problems and views which have been of concern to independent domestic producers for more than 30 years.

Your conclusion that the industry should act now in presenting its views as to the solution to these problems is most timely. In this respect, I call your attention to a statement presented before the Mines and Mining Subcommittee of the House Interior and Insular Affairs Committee by this association (Independent Producers Association of America).

This statement comments on the many government policies adopted in the past which have been beneficial to the petroleum industry and thereby the consumers of petroleum. These wise policies have in the main provided a climate of free enterprise in which the petroleum industry has operated to the benefit of all consumers of petroleum products. A copy of our statement before the subcommittee is enclosed for your information.

In addition, your editorial reflects a recognition of a program sponsored by the IPAA, which, with the cooperation of other energy industries, is designed to assure the United States a position of supremacy as to all energy sources. This program, entitled "Energy Supremacy: A Symbol of Security" has wide acceptance from all energy producing industries. A copy of this program was attached to the association's presentation to the House subcommittee.

As to other legislative and administrative problems facing the domestic producer, the IPAA has been alert and responsive. Through association efforts Congress is being informed on the value of percentage depletion as applied to oil and gas production to the consumers of petroleum products. This activity has been of particular concern to the membership of the association.

The efforts of the government, through Congressional inquiries and agency activities, to arrive at sound policies as to multiple use of our public domain have been given the widest possible support by domestic producers. Only recently, this support was reflected in testimony on the necessity of legislation to provide protection for innocent purchasers of public land leases held under violation of leasing regulations. At present ownership of leases on thousands of acres of public land is under a legal cloud as a result of government action. Only through legislation can these leases be cleared.

It has always been the policy of domestic producers to make available to the government and the public information as to the contributions of this segment of the industry and the national necessity for maintaining a strong, healthy domestic industry.

Russell B. Brown
General Counsel
Independent Petroleum
Association of America
Washington

ERRATUM

In the discussion of the new Noto oil field in Sicily (WORLD OIL, August 15, 1959, Page 154), the operator was identified as being jointly composed of AGIP and Western Geophysical Company interests. AGIP Mineraria advises that Societa CORIS is composed 100 percent of AGIP Mineraria interests.

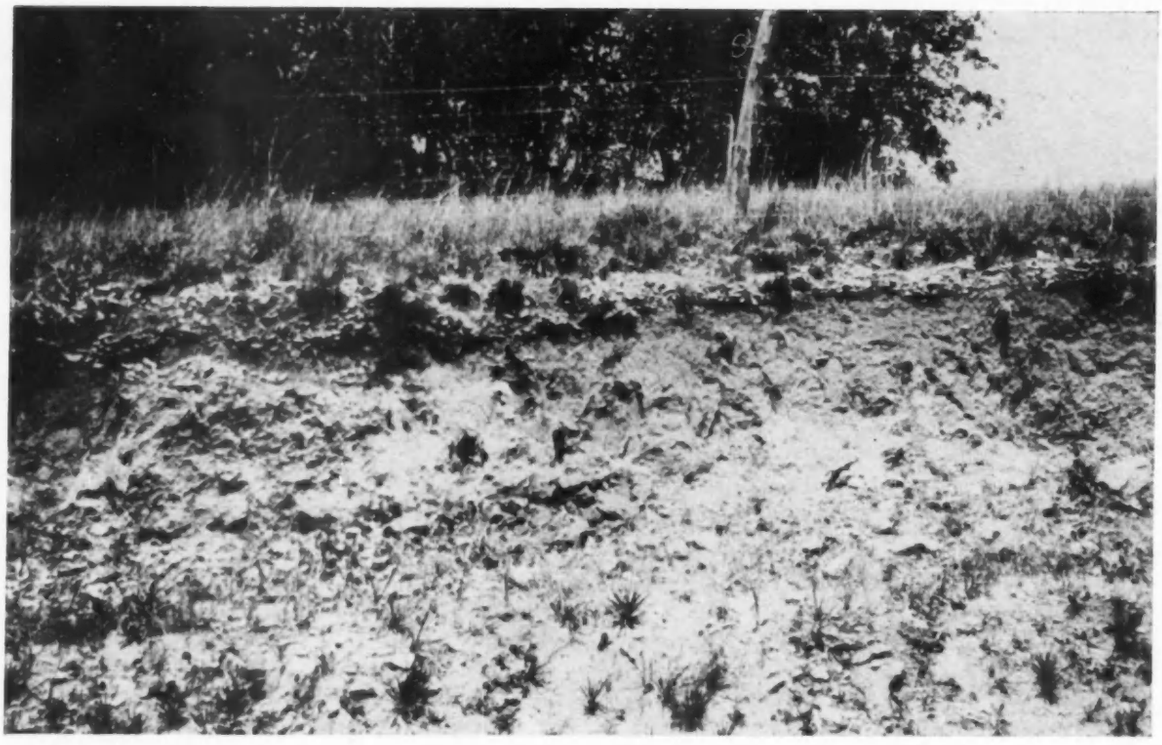


FIGURE 1—Example of a pedalfer soil in the southeastern United States. Note the distinctive layered profile of weathering.

Clay sedimentology can be useful exploration tool

When fossil control is poor in formations especially suited for clay stratigraphy, specific clay mineral composition of shale bodies in these formations may be helpful in correlation work

By Dr. B. N. Rolfe
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CLAY SEDIMENTOLOGY offers great promise in the search for oil, but only when used with discretion. Much corroborative geologic data are needed to establish the proper framework for clay stratigraphy as a correlation tool. Formations like the Tertiary Frio of the Gulf Coast and the Pennsylvanian Morrow and Springer of the Mid-Continent seem especially suited to clay stratigraphy investigations. Here, fossil control usually is poor but clay mineral composition of shale bodies appears specific within the formations. The involved problem of source rocks appears inextricably bound up with colloidal-sized sedimentary material and clay sedimentologic investigations are certain to aid in this phase of the search for oil. Thus, clay sedimentology offers no cure-all for exploration problems but appears ready to assume its position as a valid prospecting tool.

There has been much discussion lately about recent and ancient argillaceous sediments and their role in petroleum geology. Some published literature has led to confusion about the significance of clay data in the

hunt for oil. It, therefore, seems advisable to re-examine the science of clay sedimentology and try to evaluate its importance in petroleum exploration.

For this discussion, clays are defined as the fine-grained mineral components of rocks and will be limited in size to an upper diameter of 5 microns. This size range ($<5\mu$) usually is dominated by clay minerals but primary minerals like quartz and feldspar also may be present, along with amorphous iron oxides.

Clay minerals may be distinguished by composition, morphology and physico-chemical properties. Generally they are hydrous alumino-silicates, platy in shape, and exhibit varying degrees of plasticity when wet. Clay minerals are comprised of two principal building units, a layer of silica disposed as tetrahedra and a layer of alumina arranged as octahedra. Clays with but one layer of each unit are called 1:1 minerals and those with two layers of silica sandwiched about a layer of alumina octahedra are called 2:1 layer minerals. There are several groups of clay minerals, each with distinctive morphological, physical and chemical properties.

Kaolinite is the most prominent member of the kaolin group of clays. Other members of the group in addition to kaolinite, are nacrite, dickite, fireclay and halloysite. Clays in this group are 1:1 layer minerals, having one layer each of silica and alumina units. Usually they have a cation exchange capacity of between 3 to 15 milli-equivalents per 100 grams of kaolin material. The median diameter generally is about 1μ but they may be found as discrete particles with diameters as large as 20μ.

Montmorillonite is the dominant member of the montmorin group of clay minerals among which are montmorillonite, beidellite, hectorite, saponite, nontronite, etc. This group belongs to the 2:1 layer minerals and an unbalanced ionic charge is a specific characteristic. An incomplete complement of silica and alumina units results in this ionic deficiency which is evidenced by a cation exchange capacity of from 75 to 100 milli-equivalents per 100 grams of montmorin clay. Bonding between unit cells is comparatively weak and

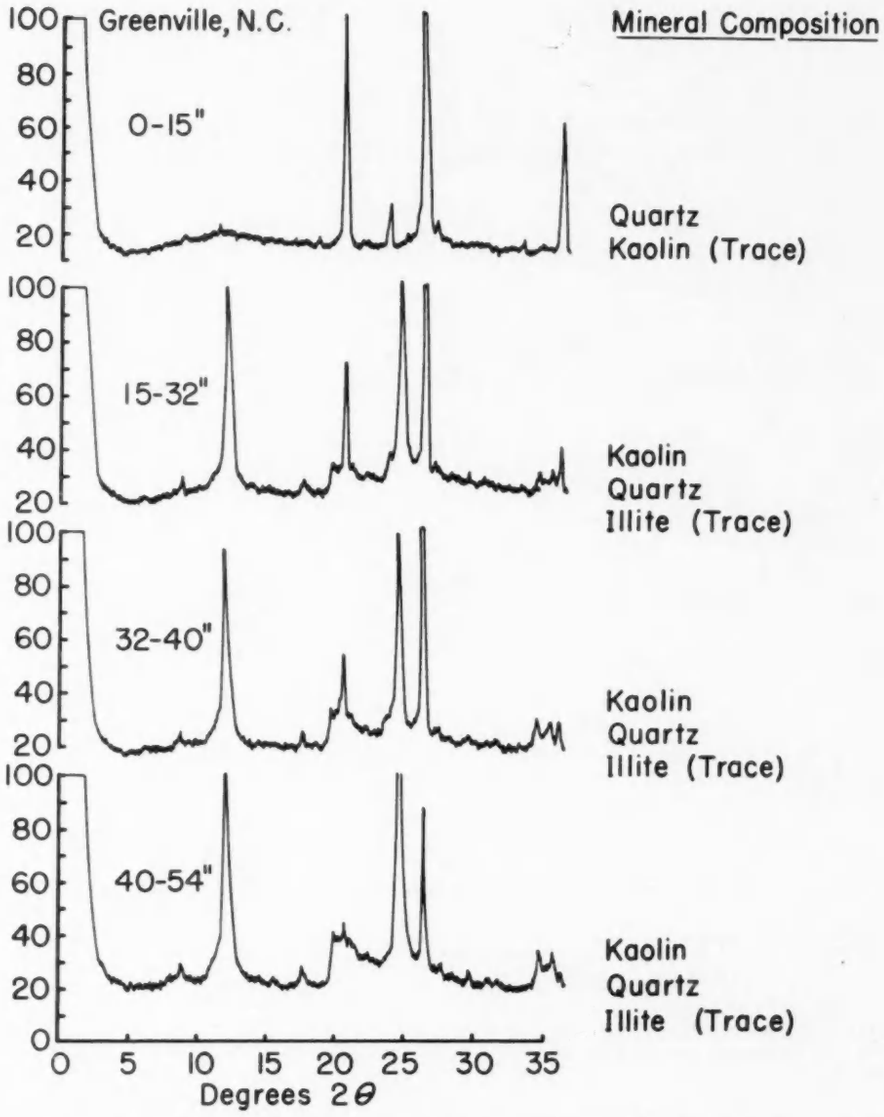

FIGURE 2—This is an X-ray diffraction profile of the pedalfer region shown in Figure 1. Quartz dominates at the weathering surface but gives way to kaolin at depth.

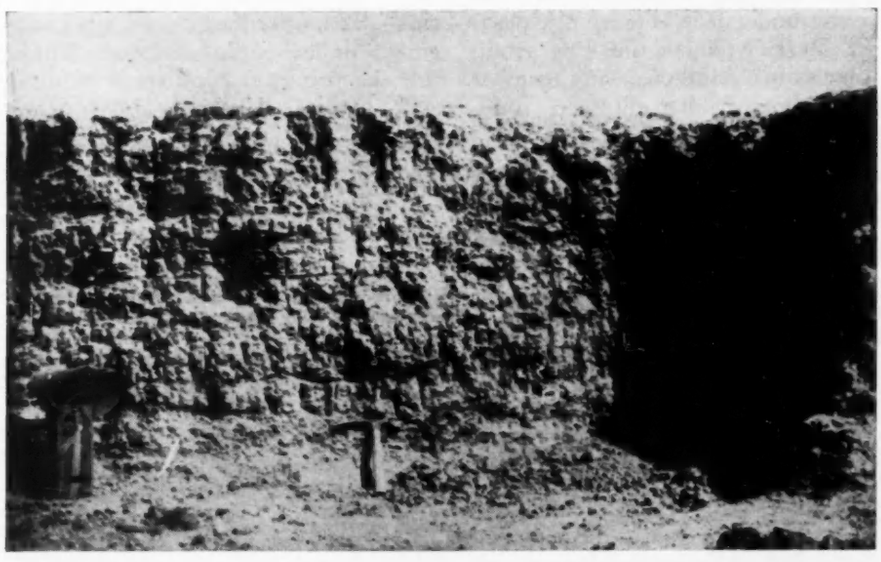

FIGURE 3—Pedocal soils such as this develop in arid to semi-arid climates. This example was taken at the Lindenmeier site in Colorado. The sediment at the line of the geologic hammer is presumed to have been deposited about 10,000 years ago. Weathering since then has not imposed any changes in the clay mineral composition of the original material.

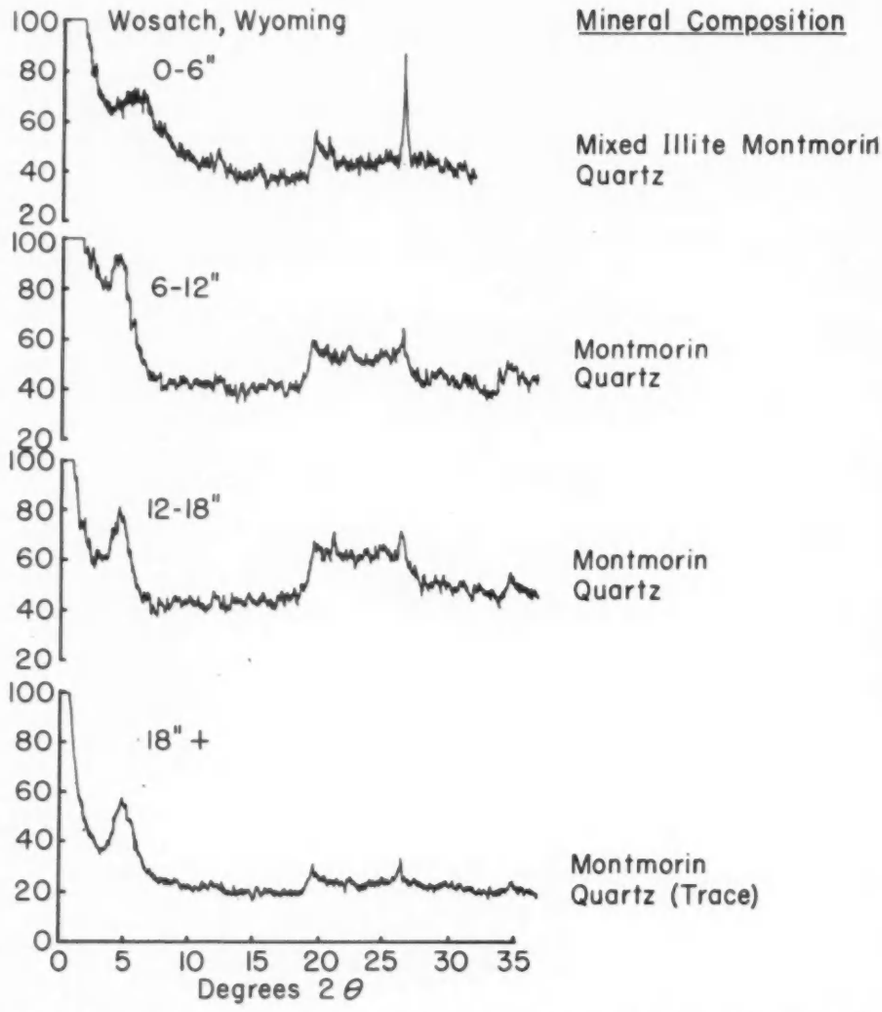

FIGURE 4—This X-ray diffraction profile is from a Pedocal Region in Wyoming. In the non-aggressive weathering environment of this area there is a slight change in the clay mineral profile.

is considered responsible for the small size of discrete montmorin particles, usually under 0.5μ diameter. Operators generally know this clay group either as bentonite or as any member of packaged drilling muds.

The illite group of mica-like clay minerals has not been subdivided, as yet. Illites, like micas and montmorins, are 2:1 layer minerals but have specific and distinctive properties. Illite particles generally are small, under 1μ in diameter. They are the principal constituent of marine shales and are not as free from mineral contamination as the two preceding clay groups. Cation exchange capacity ranges from 10 to 40 milli-equivalents per 100 grains of illite.

Other clay minerals that may be found in sedimentary rocks are: vermiculite (hydrated biotitic illite); chlorite (a magnesian illite with a layer of brucite, $Mg(OH)_2$, attached to a silica layer); and glauconite (an iron-rich illite apparently peculiar to shore line deposits). In general, the montmorin group is associated with volcanic ash and its presence in sediments is indicative of little weathering at the source; illites are considered the principal components of marine shales; and kaolins represent the stable products of weathering from primary minerals and from montmorins and illites.

The sedimentology of the fine-grained ($<5\mu$) components of rock units may be referred to as clay sedimentology. It is concerned with the study of these clay minerals and the processes by which they became a part of sedimentary rocks. The greater complexity of this fine material as contrasted to sand sizes, together with greater sensitivity to sedimentation processes, make investigations more difficult. However, the same factors offer a promise of more definitive information.

Clay sedimentology may be appropriately divided into three parts: weathering, transport and sedimentation. After a brief look at current clay studies, the elements of each subdivision will be discussed.

Current clay studies are active in recent and ancient sediments. Studies of clays in recent sediments have concentrated on the association between clay composition and both geomorphic and ecologic factors. The study of clays in ancient rocks has been restricted to developing the use of clay composition of shale members as a stratigraphic correlation tool. As is usually the case in any disputed area, confusion arises not from the data but from the interpretation attached thereto. The facility with which clays may be analyzed by X-ray diffraction units has led to its overextended use by people unfamiliar with the characteristics of clay minerals. The literature now abounds with Angstrom spacings and clay mineral names. However, quality has not kept pace with the quantity of determinations. This article is aimed at showing the need for discretion in the use of clay data.

TABLE 1—This set of data compares composition of river waters from drainage basins in the eastern and western United States. Calcium usually is the dominant cation in both climatic regions.

	pH	SiO_2	Fe	Ca	Mg	Na_{+k}	HCO_3	SO_4	Cl	F	NO_3	DS*
	Parts per Million											
Abbots Creek at Lexington, N. C. (Granville).....	6.9	18	.03	8.7	3.3	12	46	8.3	9.6	0.2	1.1	89
Cheyenne River near Hot Springs, S. D. (Wasatch)...	7.4	15	.03	384	76	130	206	1180	108	0.9	1.5	2142
Cache La Poudre River near Greeley, Colorado (Lindenmeier Site)	8.1	15	.10	325	61	156	420	750	32	0.3	6.0	1800

* Dissolved Solids

Weathering products. The weathering of a rock surface results in the formation of distinctive soil units and the production of clay-sized particles. A specific morphologic profile of weathering develops in response to several interdependent variables. Pedologists (Soil Scientists) have described a soil as being the product of five interacting factors, namely climate, parent rock, topographic relief, biologic activity and time. The distribution of clays through a weathering profile may be qualitatively estimated from the soil type. Climate and parent rock interacting through time appear to be the dominant variables with relief and biosphere relatively minor.

Thus, a pedalfer soil develops in a humid, temperate climate on an acidic rock type. Minor variations from the modal type reflect the influence of time, relief, rock type and biosphere. These soils are the result of rigorous weathering. Figure 1 is a picture of a pedalfer soil in southeast United States. The effect of climate is dominant and a characteristic clay mineral assemblage describes the weathering profile (Figure 2).

A pedocal soil develops in an arid to semi-arid climate and its morphological identity results from the imposition of a salt pattern on parent material. Such a profile is shown in Figure 3, taken at the famed Lindenmeier site in Colorado where evidence of Folsom Man's presence was found. The clay composition in such a profile of weathering varies as the original mineral stratification of the parent rock. Such a climatic environment represents non-aggressive weathering and merely serves to preserve the native composition while adding salts to the profile. The composition of fine-grained sediment from such a profile of weathering would therefore depend on the original material (Figure 4).

Presented is a picture of two modal profiles of weathering. Erosion then transforms this soil material into a sediment. Variations in the kind of erosion may confound the clay profile picture. Soil material may be stripped off slowly so that only the uppermost layer is represented in the sediment or it may be stripped in vertical fashion so that all depths are present in the sediment. The combination of other geologic data with clay information will indicate not only the probable sediment source but the associated climate as well. The implications of any clay mineral assemblage in a rock unit cannot be stated without the advantage of corroborative data from other geologic approaches.

The transport aspect of the problem is best introduced by Table 1. From this set of data about the quality of water in an eastern versus a western stream in the United States, it is learned that the greatest difference lies in the content of dissolved solids. Although streams from the west contain far more salts than those from the east, calcium is usually the dominant cation in both climatic regimes. This is significant for the evaluation of the transport characteristics of suspended sediment. Calcium is a flocculating ion and sediment therefore will be carried in a non-dispersed state.

Of equal importance is the fact that the transformation of soil material to sediment is accompanied by a great change in environment. From a weathering site with limited amounts of solution waters, the soil is emplaced in an aqueous medium, the flowing stream. Clay particles now are bathed in a salt solution and ionic equilibria are quickly established. A much greater weathering

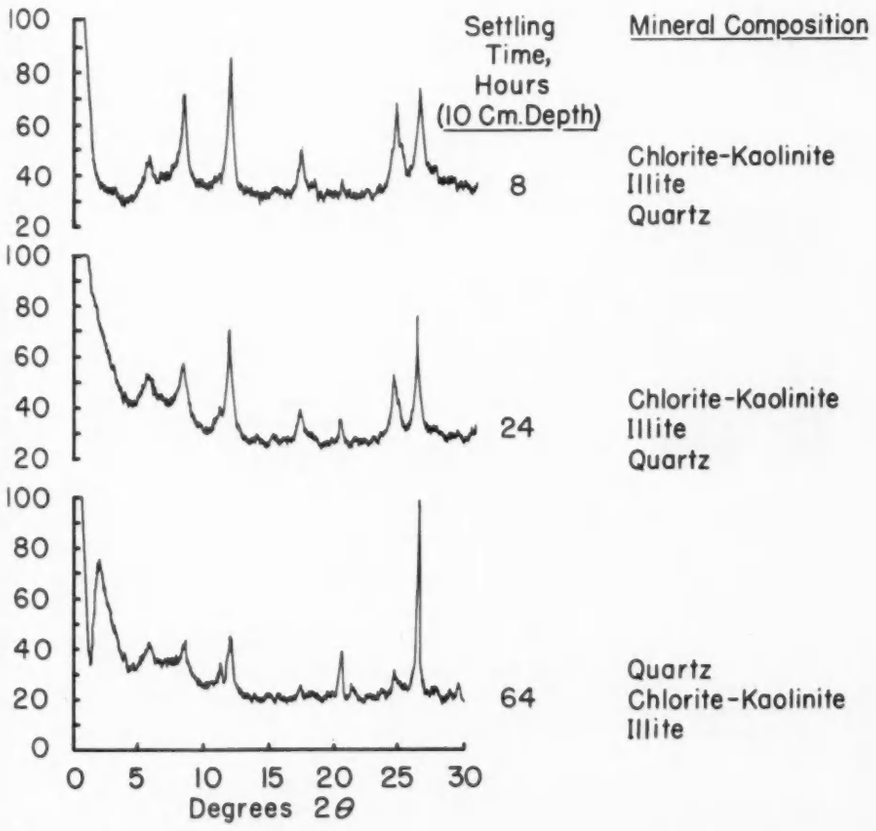

FIGURE 5—This graph shows the effect of particle size on mineral composition. At a median diameter of less than 0.2 microns the dominant mineral is quartz whereas at the upper clay limits, chlorite-kaolinite is the main constituent.

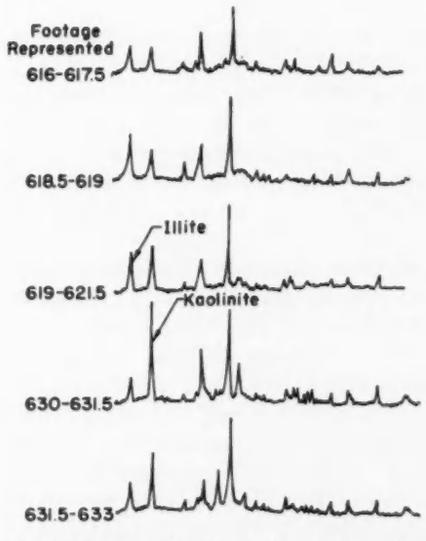

FIGURE 6—This chart shows the relationship of clay mineral composition to depth in an established section. Studies of the clay fractions of ancient sediments are on safe ground when coordinated with a proper stratigraphic background. Clay standards may be developed for established rock units in oil-bearing basins and then may be safely used for stratigraphic correlation when other tools are lacking.

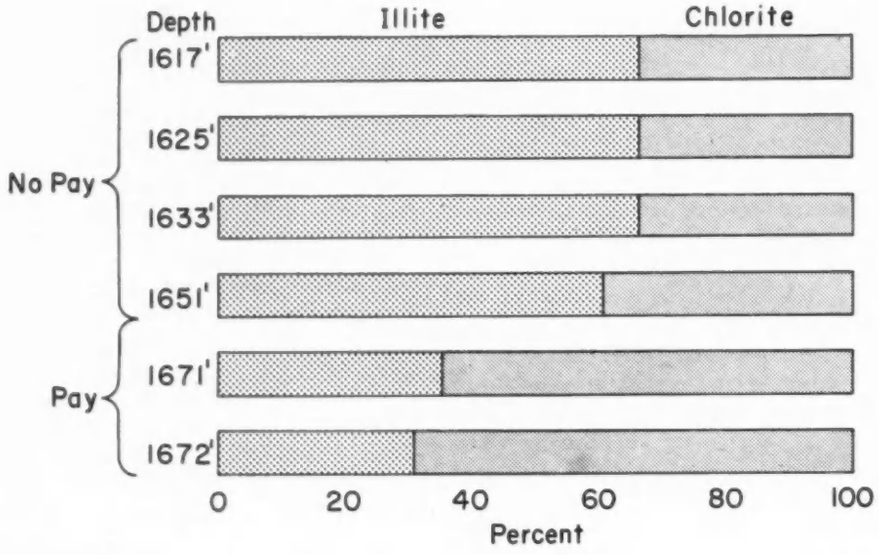

FIGURE 7—This chart shows the relationship of clay stratigraphy to production. The reason for the close association between chlorite and production is uncertain.

rate is possible during transport than is possible in the soil environment. The exchange status may change from point to point on the stream and it is likely that more presumed diagenesis occurs during transport than in the basin of deposition.

Clay sedimentology. It has been established that clays entering a marine basin of deposition are probably Ca-saturated. This is important for a proper evaluation of the probable sedimentation patterns within the basin. Because each family of clay minerals exhibits different dispersion responses to exchange ions, the composition of the inflowing suspended sediment must be ascertained. This is the initial step in understanding the possible disposition of fines in a basin.

The dispersion characteristics of clays are the result of a ternary interaction: clay-water-ionized salt. For example, a montmorin clay may travel farthest in fresh waters but fall out first in saline waters. This phenomenon is due to floc formation in the latter environment, whereas the fresh water environment maintains clay in the dispersed state. Also, hydraulics enter into the problem in that the fine-grained montmorin clays have the slowest fall velocity. A picture of the basinal sedimentation thereby may be derived from the clay distribution profile. Agitated waters will yield a different clay disposition picture from that of quiet waters.

Figure 5 illustrates the effect of particle size on the composition of an assemblage of clay minerals. These data are for settling in a beaker of distilled water and their extrapolation potential depends on proper correction for quality of the water and intra-basin hydraulics. It should be remembered that changes in particle size are easily effected by chemical interactions and the settling velocities of clays have to be adjusted accordingly.

The preceding discussion has emphasized the difficulties of unilateral conclusions from clay sedimentologic data and renders suspect any geologic interpretations so derived. However, proper adjustment of such data to other geologic approaches should not only remove this difficulty but strengthen the overall picture. Figure 6 illustrates the relationship of clay mineral composition to depth in an established section.

Similarly, investigations into the clay fraction of recent sediments are best effected in combination with geomorphic and ecologic control. Samples should be selected on the basis of describable basinal landforms like lagoon, near-shore bar, etc. and should be confined also to ecologic communities like marsh, swamp, peat deposit, etc. The data that is derived from such investigations then may be tied to an established basinal site. The analysis of similar basins in ancient rocks may be aided by clay sedimentology and environmental interpretation derived therefrom.

Another aspect of the relation of clays to the search for oil is concerned with the origin of oil. Some of the greatest promise for clay research lies in studying the clay-organic matter relationship. Commercial accumulations of oil may be derived from detrital hydrocarbons or from the transformation of other forms of organic matter. In either case, the role of sedimentary fines is important. Considering only the detrital aspect of hydrocarbons, one can see that there are two possible sources of such material, either soil-derived or in-basin. Definition of either aspect will be aided by knowledge of the associated clays. Information about probable weathering products from specific climatic regimes should help establish the biosphere responsible for detrital hydrocarbons. Should the hydrocarbons be authigenically (in-basin) derived, associated clays may spell out the specific ecologic environment for such organic productivity.

About the Author

Dr. B. N. Rolfe is supervisor of exploration research at the Tulsa laboratory of the Cities Service Research and Development Company. He received B.S. degrees from City College of New York and Cornell University, respectively, in 1935 and 1938. Since that time, he has been working with clays and sediments. He has graduate degrees in Mineralogy; the M.S. in 1950 from Virginia Polytechnic Institute and Ph.D. in 1952 from Pennsylvania State University. He was with the U.S. Geological Survey from 1951 to 1956 when he came with Cities Service.

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New interest is developing in Argentina's oil basins

Argentine outlook encouraging; Paraguay hopeful; Uruguay uncondemned; south Chile proven

This article is the second of a series of four discussing sedimentary regions and oil possibilities of South American countries. The first, describing movements of Cambrian and younger seas and the areal extent of resulting marine strata deposited and buried, appeared in the September 1959 issue of WORLD OIL.

By Carl A. Moore, Chairman, School of Geological Engineering, University of Oklahoma

ARGENTINA'S OIL PRODUCTION is from five different basins scattered over 1,800 miles from Salta province in the extreme north to Tierra del Fuego. Productive areas range from the Andes foothills on the west to the Atlantic coast and offshore at Comodoro Rivadavia. Several other sedimentary basins covering vast areas are not yet productive but are prospective. Production dates from 1907 at Comodoro Rivadavia, which remains the nation's most prolific oil province.

Crude oil production in 1958 in Argentina was 35,697,187 barrels (97,800 barrels daily). There were 174 flowing and 3,525 pumping oil wells at the end of 1958. In addition, 775 oil wells were shut in. Considered by areas, the 1958 crude oil yield was as follows: Comodoro Rivadavia, 54 percent; Mendoza, 27 percent; Plaza Huincúl, 15 percent, and Salta, 4 percent.

Comodoro Rivadavia. Comodoro Rivadavia is located on the east coast of south-central Argentina in an open marginal basin between the Chubut and Santa Cruz massifs. Crude oil production is from upper Cretaceous sandstones on faulted anticlines. Producing depths are between 3,300 feet and 6,900 feet. Oil gravity is about 25 degrees API. Figure 1 shows the sedimentary section.

The future appears to be bright. Particularly with current new contracts getting underway to provide drilling of as many as 4,500 new wells in this region, it should be possible to locate new structural and/or stratigraphic accumulations. Stratigraphic traps will very likely be developed in onlapping sandstones of the previous open marginal (Cretaceous) sea.

Neuquén (Plaza Huincúl) area. This is one of the older producing areas of Argentina. It is located in central Argentina in the sub-Andean foothills belt. Production is from eroded sandstones of middle Jurassic (Dogger) age (Figure 2) where these sandstones are covered by dark gray to brown shales of the upper Jurassic (Tithonian). Each field in the area has a relatively small productive area.

First production was proved in 1918 from monoclinal traps, "bald-headed" structures, and some stratigraphic traps. Average depth of pay is 2,900 feet, with the deepest well being reported to be 8,000 feet, still in the middle Jurassic. Gravity of the oil is about 30 degrees API.

Future. Exploratory drilling has been somewhat disappointing in recent years, but was enhanced in 1957 by an oil discovery at La Borrosa, northwest of Neuquén, and due north of Challaco. Other discoveries were reported southwest of Neuquén, and in Mendoza. There is a possibility of deeper drilling into upper Triassic rocks productive in the Mendoza area to the north.

Mendoza Area (Cuyo Basin). This is the northern producing area in central Argentina. Production is from

FIGURE 1—Generalized Sedimentary Section, Comodoro Rivadavia Area

Tertiary		Non-marine, mixed, and marine (mammal remains in Eocene)
Cretaceous	Upper	Salamanca shale, beds sandstone* Chubut formation Glauconitic sandstone First oil sandstone* Gray shale, non-marine? Blue shale, with beds of sandstone* Second oil sandstone* Sandy shales, oil shows Third oil sandstone* Blue shale, lignite beds
Jurassic?		Thin sandstone* Quartz porphyry Basement

* Oil producing horizons.

FIGURE 2—Generalized Sedimentary Section, Mendoza and Neuquen Areas

Tertiary		Red beds, with volcanic material[1]
Cretaceous	Upper	Roca formation (dinosaur remains) Malargue formation Pehuenche non-marine shales, and sandstones
	?—— Middle	Carranza sandstone Ranquiles formation Neuquén, or Barrancas red beds Rayosa formation
	Lower	Agrio dark shales, marine Mulinchinco or Batro series Quintuco shales, few limestones
Jurassic[3]	Upper[2]	Loteno sandstone* Aquinco formation Llajas limestone
	Middle	Dogger sandstone*[3]
	Lower	Lias—Los Molles, shales and sandstones
Triassic	Upper	Rhaetic beds; Victor horizons*[4] Volcanic series
Permo-Carboniferous		Gondwana glacials Sandstones
Devonian Silurian		Sandstones and shales
Ordovician		Limestone, dolomite, shales

* Oil producing horizons.
[1] Some oil-productive upper Tertiary at Mendoza.
[2] Oil production is also found in upper Jurassic sandstones at Neuquén.
[3] Neuquén only. Jurassic generally absent at Mendoza.
[4] Mendoza only.

FIGURE 3—Generalized Sedimentary Section, Salta Area

Tertiary[1]	Chaco formation[1]
Cretaceous	Candado sandstone
Permo-Carboniferous	Gondwana formation San Telmo sandstone Escarpment sandstone Tarija shaly standstone* Tupambi sandstone*
Devonian	Dark marine shales[2]
Ordovician	Shales, few sandstones and limestones
Cambrian, Upper	Sandstones and shales

* Oil producing horizons.
[1] Some oil production in lower Tertiary Rio Pescado section, from 2,800 to 4,500 feet.
[2] Some oil found in Devonian sands at Ramos at depths of 3,200 to 3,800 feet.

structural accumulations. Locating commercial production was rather slow. Wells were completed about 30 years ago at depths as shallow as 760 feet in non-marine Pliocene beds at Tupungato. Subsequently about 20 shallow wells were completed, finding oil and considerable salt water at an average depth of 1,500 feet from fractures.

In 1938, oil production was found at about 5,600 feet in what was named the Victor zone (upper Triassic)—a thick series of fractured volcanic tuffs. New, lower Triassic pays have since been found in sandstones and tuffaceous sandstones and shale below the uppermost Triassic pay (Victor Claro).

Current production from the Mendoza area exceeds 25,000 barrels daily. Gravity is about 27 degrees API. The crude has a high paraffin content. Six fields are producing. L. R. Development Company is currently drilling on La Ventana structure.

Some known structures have either been inadequately drilled or not at all. In addition, pre-Triassic possibilities are largely untested.

Salta area. This area is located in the northern part of Argentina, adjacent to the Bolivian boundary. It lies along the borderland side of the sub-Andean trough, close to the mountains. Oil is produced from anticlines which trend in a general north-south direction, parallel to the mountains.

First production was found in the Salta area in 1925 on a surface structure. Production is from Devonian sandstones, and from Permo-Carboniferous glacial deposits. There is a minor zone of production in Tertiary rocks at Río Pescado. Present limited production is from anticlines (Figure 3).

In recent years, Yacimientos Petrolíferos Fiscales (YPF) has developed reserves of deep, high-pressure gas-condensate production below 12,000 feet at Campo Durán and Madrejones fields. This production is from Tupambi sandstones near the base of the Permo-Carboniferous section. Individual well potentials are reported at about nine million cubic feet plus about 1,000 barrels of condensate daily. Recoverable liquid hydrocarbon reserves at Campo Durán and Madrejones have been appraised at about 200 million barrels each. Facilities to handle production and a 1,000 mile, 24-inch pipe line to Buenos Aires are now being built. Pipe line facilities to move Salta crude to refining centers are also being expanded.

Some of the structures in Salta and some of the trends of possible stratigraphic accumulations continue into Bolivia. Argentina and Bolivia will jointly operate oil and gas fields which straddle their common border.

Deeper possibilities may exist in the lower Paleozoic rocks. However, such potential is unknown, since the oldest oil-productive sediments in South America are Devonian.

Magallanes (Southern) Basin. This basin contains upper Jurassic, Cretaceous and Tertiary sediments and runs roughly north-south from extreme southern Argentina through Tierra del Fuego east of the Cordilleran Front. Chile's only current oil production is in the Magallanes Basin, primarily on Tierra del Fuego. In Argentina, Cañadón Seco field in Santa Cruz produces 30.6 degree API gravity crude from a basal Jurassic sandstone on a faulted anticline at about 4,100 feet. Two other fields, Cañadón Leon and Mesita Espinosa have been found on the Argentine mainland.

On the Argentine side of Tierra del Fuego, YPF considers five structures to be proven for oil and/or gas production. Rapid drilling was expected to be underway late in 1959 to evaluate these and other structures. Basal Cretaceous producing sandstones and the remainder of the sedimentary section on Tierra del Fuego are generally similar to the Chilean section (Figure 4).

The Magallanes basin is asymmetrical with the mobile

FIGURE 4—Generalized Sedimentary Section, Magallanes (Southern) Basin*

Quaternary		Fluvio-glacials
Pliocene		Palomares sandstone
Miocene		Loreto sandstone; carries coal
Eocene	Upper	Lena Dura shale Tres Brazos sandstones
	Lower	Agua Fresca shale
Cretaceous	Upper	Chorrillo Chico siltstone Rocallosa sandstone Fuentes shale Rosa conglomerate (small oil shows) Inoceramus shale Springhill sandstone**
Jurassic?	Upper	Serie Tobifera (tuffs and porphyrite)
Precambrian		Basement rocks

* This section is derived from the Chilean side of Tierra del Fuego. Cañadón Seco field, farther north in Santa Cruz, Argentina, produces oil from a basal Jurassic sandstone.
** Oil producing horizon.

FIGURE 5—Generalized Sedimentary Section, Parana Basin (Argentine portion)

Cenozoic		Fragmental basalts, conglomerates and sandstones; unconsolidated
Cretaceous? Jurassic?		
Triassic	Upper	Basalts and diabase, up to 2,000 feet in thickness
	Middle	Red beds, conglomerates, sandstones
	Lower	Red beds, reptile remains
Permian	Upper	Passa Dos series Irati black shales, with nodules of limestone and chert
	Lower	Upper Tubarao sandy shales
Permo-Carboniferous	Upper	Lower Tubarao series
	Lower	Itarare glacial conglomerates, sandstones, shales
Devonian		Ponta Grossa dark shales, few sandstones Faxina-Furnas coarse sandstones
Precambrian		Basement rocks

borderland on the west. Just east and northeast of the Andes Mountains is the deepest portion of the basin, where over 10,000 feet of sediments have been reported in wells. From this deep trough, the basin becomes shallow toward the east, but the area of the stable foreland is to be found farther east, probably beneath the Atlantic.

The thin Springhill sandstone of basal Cretaceous (or upper Jurassic) age produces most of the oil and gas found thus far in Tierra del Fuego in Chile. Some oil has also been found in the eroded top of the "Serie Tobifera," composed of tuffs, porphyrite, and thin intercalated sandstones. The Tobifera is Jurassic, lying below the Springhill and above pre-Cambrian basement.

Unproved Basins. The Chaco-Paraná Basin covers a huge area in northeastern Argentina. This basin covers about as much territory as the other basins in the country combined. YPF recently asked for bids to develop this basin and to obtain checkerboard acreage in any productive areas found in the future.

The Paraná is a unique, symmetrical basin with an unusual geological history (geological description taken from Baker, 1923). The basin is located in Argentina, northern Uruguay, eastern Paraguay, and southern Brazil. (See Figures 1-7 in first article of series.)

The geology of the basin is obscure except around the edges because of the extensive Triassic lava flows that cover most of the formations. These basic flows form the surface rock in the southern part of the basin. Around the margins of the lava flows are found the older sedimentary rocks (Figure 5).

In the basal portions of the lava there are sandstones which may be either interbedded, or they may have been intruded by diabase as sills. In some areas there are very thin sandstone beds in the upper portions of the lava flows. Where these sandstones are present, they are usually metamorphosed to a very hard quartzite.

Following the great lava flows, the basin was deformed into the present Paraná Basin.

Oil possibilities. A number of favorable conditions for the occurrence of oil in the Paraná Basin may be enumerated:

- Asphalt-saturated sandstones crop out beneath the flows in the northern part of the basin.
- Wells that have penetrated the Permian Irati shale have found small shows of black, heavy oil in the sandstones associated with the dark shales.
- There are two reports of non-commercial green, paraffinic oil in the tillites of the Itarare formation. This oil may have migrated up from the Devonian rocks, which had yet to be penetrated in a well in Argentina.

On the other hand, there are a number of unfavorable conditions in the basin:

- All post-Devonian sediments in the basin, so far as has been determined, are of continental origin.
- Lensing and irregularities of the Permo-Carboniferous glacial deposits impede correlations from well to well.
- Sills and laccoliths have in places bulged the beds into dome-like structures which may attract oil exploration resulting in failure.
- Lava beds cover most of the entire basin and obscure all the underlying geology. These flows impede geophysical studies of the underlying structures.
- If oil should be found in commercial quantities, its extraction will be burdened by the cost of drilling through perhaps 2,000 feet of basalt or diabase. Air drilling may ease such a difficult penetration problem.

Portions of the Salado Basin in Buenos Aires province and the Eopaleozoic geosyncline in the extreme northwest were also included in the same recent tender for

bids mentioned at the start of the Paraná Basin discussion.

The Rio Colorado Basin, located near the Atlantic Coast between Bahía Blanca and the Gulf of San Matias, contains Tertiary, Cretaceous, upper Paleozoic (glacial deposits), and Devonian sediments. Direct connection with the Neuquén Basin is indicated. The area is being explored by Royal Dutch Shell pursuant to a 7,360,000-acre contract concluded recently with YPF.

The Nirihuau Basin near the Chilean border in Chubut and Rio Negro is a small, unproved basin containing mixed marine and non-marine Tertiary sediments. Some oil shows and gas seeps have been reported.

The future of petroleum in Argentina can be good. There are favorable areas in which source and reservoir rocks are to be found, in good position with respect to timely folding. Many untested structures are known and have been mapped.

Argentina is nearing the second phase of exploration: i.e., approachment of the completion of testing of anticlinal and domal structures, with the advent of emphasis on stratigraphic trap accumulations. Most of the fields are relatively shallow. Careful geological studies should point toward deeper possibilities.

URUGUAY

The only possibilities for the production of oil seem to lie in the Paraná basin as previously discussed. Any possibilities of off-shore exploration in the Plata River lie in the future, as the complete geological history is better understood.

PARAGUAY

There is no production in Paraguay. Present activity consists of leasing and exploratory drilling. The tests are being drilled in the western Chaco area in northwestern Paraguay, adjoining Bolivia.

The basin position of these concessions appears to be on the borderland side of the sub-Andean trough, actually out of the folded borderland area. Traps should be primarily structural, with stratigraphic control being of secondary importance. Both source and reservoir rocks should be present. The present concessions appear to be well located with respect to basin position. Chances of the development of oil production appear favorable.

Initial wildcat drilling in Paraguay showed that Tertiary overlies Devonian black shales.

CHILE

Crude oil production in Chile has been restricted to the Tierra del Fuego portion of the Magallanes Basin. With the recent discovery of oil at Punta Delgada Este and Tranquilo oil fields on the mainland near the Magellan Strait, oil production has been established there. Oil and gas were found at Punta Delgada about seven years ago, but it was not considered commercial at the time.

Some exploration is underway in the northern desert provinces, and it is likely that some exploratory drilling will be done there in 1960 or 1961. Airborne magnetic, seismograph, and field geological work has been done recently in Tarapacá province, in areas near the Peruvian border.

Magallanes Basin. Because there is greater current interest in Argentina, Chile's only oil-productive basin has already been discussed in connection with Argentine possibilities. Figure 4 shows the generalized sedimentary section of Tierra del Fuego.

The productive Springhill sandstone does not outcrop—it grades into shale toward the west, and thickens toward the east. Oil shows have been reported in the Rosa conglomerate series which is higher in the section.

Average depth of production is approximately 7,000 feet, becoming shallower toward the east. Gravity of the oil is high, around 40 degrees API. It has a high gasoline content.

The Manantiales field was discovered in 1945 on a seismograph prospect. Current exploratory activity includes the stepping up of geophysical work, and the correlation of subsurface geological data and geophysical data. Production comes from 18 small fields, of which the Cullen, Sombrero, Victoria Sur, Chillan, and Tres Lagos fields are the largest and most important. The Nandu field produced the first commercial quantities of gas.

Future. The producing Springhill sandstone trends northwest—southeast and crosses the Argentine border on Tierra del Fuego. The northern extent of the sandstone is not generally known. Under proper geological conditions of structure and sand development, this sandstone should be found productive to its eastward limit. To the west, the Springhill is found much deeper, and its westward extent has not been reported.

At present, five rigs are being used in the development program of the Springhill sandstone, and production continues to increase each year. With the single main productive horizon, however, the Magallanes basin possibilities are naturally limited. A few oil shows of minor importance have been reported above the Springhill, and since this sandstone apparently rests on basement rocks, there are no deeper possibilities.

Empresa Nacional del Petroleo (ENAP), the Chilean government oil monopoly, drilled a deep dry hole below 12,000 feet in the Cullen field during mid-1958, and was reported in volcanic rocks at that depth.

Geological exploration is currently being conducted in northern Chile. There are Jurassic and possibly younger sediments with oil possibilities.

ACKNOWLEDGMENT

A full list of references will be included at the end of Part 4 of this series of articles.

TO BE CONTINUED

For Your PRODUCTION File

Here's how to improve your gas lift installations

PART 3: Simplified valve spacing chart for intermittent gas lift design

By H. W. Winkler, Engineer
Camco, Incorporated, Houston

A NEW, SIMPLIFIED gas lift valve spacing chart has been developed which allows operators to quickly determine valve spacing in low productivity intermittent wells. Suitable intermittent gas lift valve installations for this type of well can be determined in the field when little or no data are available for more precise calculations.

It is often necessary to design an intermittent gas lift installation rapidly, when practically no data are available. With limited data, the design usually is based on standard valve spacing equations. Gas lift valve specifications, gas column weight, well temperature, etc., required for calculating a closing pressure analysis (used for detailed valve spacing calculations) are not considered.

Figure 6 is a simplified valve spacing chart for low productivity intermittent wells. The chart is based on the following equations:

$$\text{Depth of Top Valve, } L_1 = \frac{\text{Surf. KO Press.}}{\text{SFG}} \qquad (3)$$

For spacing remaining valves:

$$\text{DBV} = \frac{P_{vo} - \text{FG (DVA)}}{\text{SFG}} \qquad (4)$$

and:

$$\text{DOV} = \text{DVA} + \text{DBV} \qquad (5)$$

Where:

DVA = Depth of valve above, L_1, L_2, etc., feet
DBV = Distance between valves, feet
DOV = Depth of valve, L_2, L_3, L_4, etc., feet
FG = Flowing gradient, psi/foot
P_{vo} = Opening pressure of valve above at 60° F. in tester, psi
SFG = Static fluid gradient, psi/foot
Surf. KO Press. = Surface kickoff injection gas pressure, psi

The following assumptions were used in Equations 3, 4 and 5 for calculating the curves:

1. Opening pressure (P_{vo}) of top valve at 60° F. in tester equals surface kickoff injection gas pressure.
2. Valve opening pressures (P_{vo}) were decreased 25 psi for each succeedingly lower valve.
3. Surface wellhead tubing back pressure was disregarded for spacing all valves.
4. Static fluid gradient (SFG) of 0.5 psi per foot was used for spacing all valves.
5. Distance between valves was based on an opening pressure (P_{vo}) of valve above at 60° F. in a tester and a flowing gradient (FG) of 0.04 psi per foot.

If the top valve has an opening pressure of 800 psig, the next lower valve will have an opening pressure of 775 psig; the next lower valve's opening pressure will be 750 psig; and so on. To assist unloading, many valve strings are designed using this technique of lowering valve opening pressures 25 psi for each deeper valve.

Unless separator pressure exceeds 40 or 50 psig, the tubing pressure can be disregarded, particularly if a static fluid gradient of 0.5 psi per foot is used in Equation 4. If difficulty should occur due to the separator pressure, the well can be unloaded into a pit.

A flowing gradient of 0.04 psi per foot generally is recommended for calculating valve depths for low productivity intermittent wells. The opening pressure P_{vo} at 60° F. of the valve above also is often used for calculating the depth of the next lower valve.

Two problem examples are presented to illustrate use of the chart for designing intermittent gas lift installations. One well has a high fluid level and the other well has a low static fluid level. The procedure for determining valve depths for both wells is shown by dash lines and arrows in Figure 6.

Figure 6 and example problems on following pages . . .

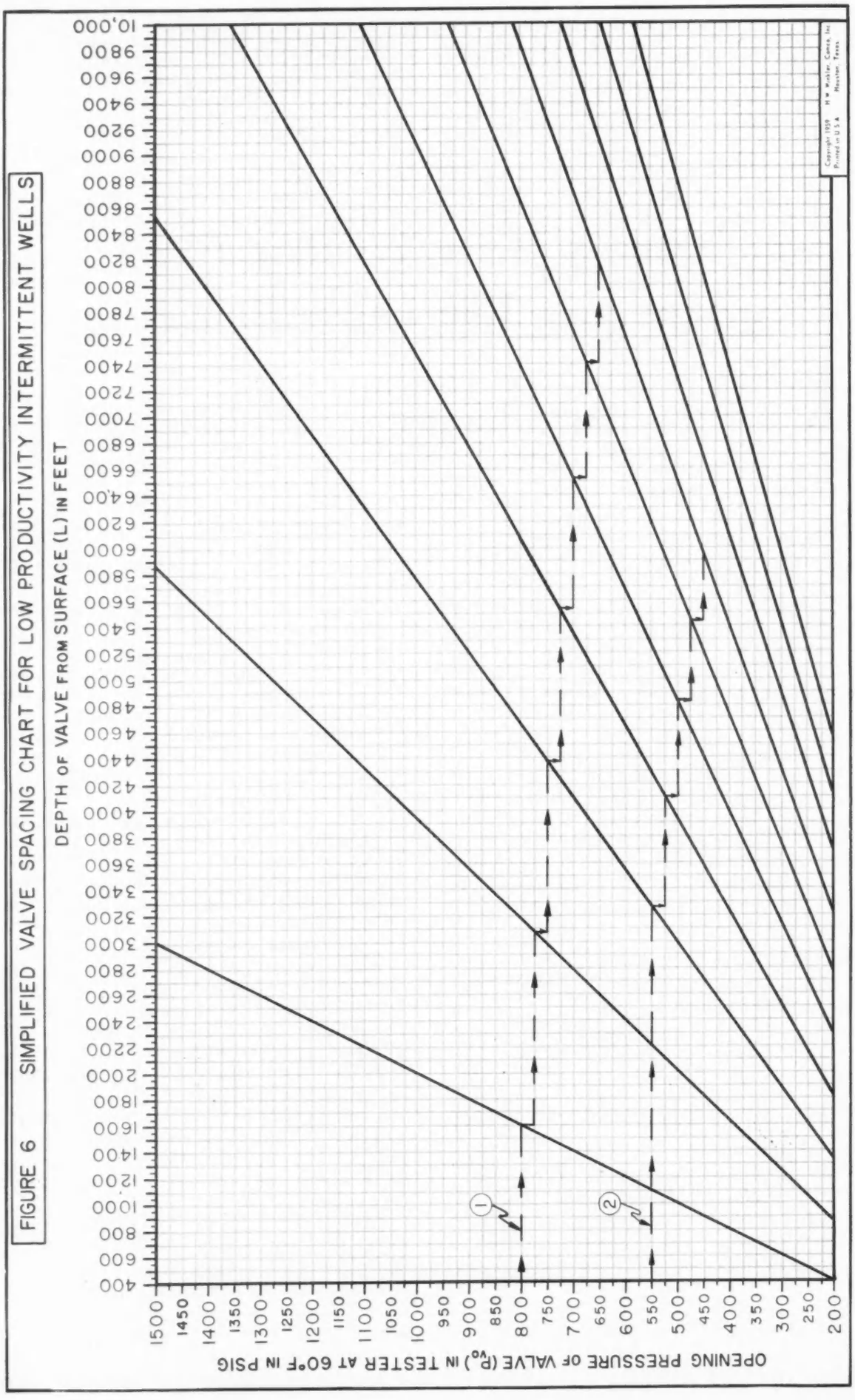
FIGURE 6 SIMPLIFIED VALVE SPACING CHART FOR LOW PRODUCTIVITY INTERMITTENT WELLS
DEPTH OF VALVE FROM SURFACE (L) IN FEET
OPENING PRESSURE OF VALVE (P_{vo}) IN TESTER AT 60°F IN PSIG
400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000 5200 5400 5600 5800 6000 6200 6400 6600 6800 7000 7200 7400 7600 7800 8000 8200 8400 8600 8800 9000 9200 9400 9600 9800 10,000
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2
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Given:

PROBLEM EXAMPLE 1

The well has a high bottom hole pressure and low productivity index and must be loaded to the surface to pull tubing for installation of gas lift valve mandrels. Gas lift valves should be run as deep as possible in this well. The only additional known data are:

1. Surface kickoff injection gas pressure = 800 psig
2. Top of perforations = 8,200 feet

Find:

Depth of gas lift valves from Figure 6.

Solution:

From Example 1, Figure 6:

P_{vo} Opening Pressures in Tester at 60° F. (psig)	L Valve Depths from Figure 6
800	1600
775	3070
750	4375
725	5525
700	6530
675	7410
650	8165

Given:

PROBLEM EXAMPLE 2

This well has a low bottom hole pressure and low productivity index. Since the bottom hole pressure is low, the well is not loaded before pulling tubing to install mandrels. Gas lift valves should be run deep as possible in this well. Additional well data are:

1. Surface kickoff injection gas pressure = 550 psig
2. Top of perforations = 6,000 feet
3. Static fluid level = 3,400 feet

Find:

Depth of gas lift valves from Figure 6.

Solution:

Since the static fluid level is 3,400 feet, locate the top valve at the depth indicated by the intersection of the 550 psig horizontal pressure line and the first diagonal valve line (from the right side of the chart) which will result in a top valve depth above 3,400 feet (Example 2, Figure 6).

P_{vo} Opening Pressures in Tester at 60° F. (psig)	L Valve Depths from Figure 6 (feet)
550	3260
525	4100
500	4825
475	5440
450	5950

The basis for Figure 6 should be clearly understood before using this chart indiscriminately for spacing valves for all intermittent wells. If the operating injection gas pressure is 100 to 150 psi less than the injection gas pressure available for unloading (kickoff pressure), the valve opening pressures can be decreased 25 psi for each lower valve and still utilize the operating injection gas pressure. However, if the operating pressure and kickoff pressure are equal or nearly equal, and these pressures are low relative to the required depth of lift, detailed valve spacing calculations are recommended to prevent an unnecessary sacrifice in injection gas pressure which could be the difference between efficient and inefficient gas lift operation.

There's more to come . . .

The first two parts of this series on gas lift installations have covered (1) pressure at depth determinations (Page 63, August 1 WORLD OIL) and (2) a simplified method for constructing gas pressure at depth curves (Page 73, September WORLD OIL). In addition to the discussion this month on a simplified valve spacing chart for intermittent gas lift design, there are four more installments to come that are "musts" for your production files.

Coming issues of WORLD OIL will include:

NOVEMBER: A method for estimating injection gas requirements for intermitting gas lift wells (dual and single completions).

DECEMBER: How to estimate gas requirements for intermittent lift.

JANUARY: The purpose and use of flow valve specifications.

FEBRUARY: How to hook up surface controllers for special gas lift applications.

. . . save these articles for your production files

How to evaluate cuttings in air and gas drilling

Microscopic study provides ample data on shows, lithology, amplifying surface evidence

By H. Fred Downs, Geologist
Technical Drilling Service, Inc.
Midland, Texas

AIR AND GAS DRILLING has created a number of advantages for the geologist as well as having created some disadvantages for him.

Determination and evaluation of oil and gas shows and sample description comprise wellsite geologists' primary functions. Various techniques for show evaluation and sample running used in conventional fluid rotary drilling have been modified somewhat by the use of air and gas as circulating media.

Probably the foremost objection to the use of air or gas for drilling has been the small size of sample returns and the consequent loss of lithologic detail. However, discussions with numerous geologists actively watching wells being drilled with air or gas largely invalidates the assumption that air or gas drilled samples are too small to describe accurately.

Use of higher magnification in binocular examination permits adequate description in most cases, with little loss of detail. Thirty to forty-five power magnification usually satisfies most needs in running samples. Available binocular microscopes have wide fields of vision at high power. This permits long periods of sample examination without excessive eye fatigue.

Caution is urged, however, in using higher power for sample running to avoid false impressions of porosity and permeability.

Although sample size may run smaller than 1/256 mm, the average sample is no smaller nor is it harder to work with than water drilled samples.

Microscopic examination of dry air or gas drilled samples is easily accomplished. Changes in color, composition and texture are immediately apparent. Formation boundaries are easily determined in this manner and are often more clearly defined than with fluid drilled samples. The relative absence of cavings and sample lag accounts for this advantage.

Show evaluation. Oil stains and odor are readily apparent in fine cutting returns. Fluorescence and "cut" are usually intense—probably owing to more surface area exposed in the sample.

While loss of some detail in sample examination is a handicap, qualitative evaluation of porosity and permeability is greatly enhanced while drilling with air or gas. For example, a porous and permeable formation containing fluid will flow oil or water into the well bore while drilling is in progress.

Surface indications of the bit encountering fluid are sudden cessation of returns and a sharp increase in circulating pressure. Under normal conditions, and with equipment of sufficient capacity to circulate at higher pressures, continued blowing will produce fluid at the surface.

Gas will surface in the same manner as liquid and may be measured at the surface. Continuous gas indicators and analyzers are recommended on air and gas drilling operations.

However, it is possible to drill through a productive zone without losing returns and with only a slight increase in circulating pressure. Such formations are usually shales and sandy shales with extremely low permeability. They may require very heavy fracturing treatments to attain commercial production. Samples from these zones are usually saturated with oil and show good fluorescence.

Coring may be desired in these formations for reservoir information. Drill stem tests are not suggested if the interval will not produce fluid after a period of continued blowing.

If the returning fluid is oil or in some instances, water, the geologist may wish to core and test for reservoir characteristics. If water is the returning fluid and flow exceeds three barrels an hour, the formation may be squeezed or the operation may be switched to "mist" drilling or aerated fluid drilling.

The geologist benefits from a "mist" or aerated fluid program by the larger cuttings attained. The advantage of continuous show evaluation is retained. Use of foaming agents in "mist" or in aerated fluid drilling is to provide a means of lifting water from the bottom of the hole.

All foaming agents, bit lubricants, and corrosion inhibitors should be examined by the wellsite geologist for fluorescence before they are used. Normally, these additives in current use are free from fluorescence and do not interfere with cutting evaluation.

To the author's knowledge, the use of foaming agents does not void an oil show in samples by washing or fluid infiltration — at least to no greater extent than do conventional drilling muds or clear water.

Although the manner in which the average show presents itself may differ from that of fluid drilling, the hazard of missing shows, under proper air or gas drilling operation is slight. Porosity and permeability may be poorly defined from sample returns, but the fact that a formation possesses these characteristics is not lost. Detailed studies can be made from cores and actual drillstem tests, if desired.

Sample collection. Collection of air or gas drilled samples is accomplished by utilization of a simple trap. This trap may be a collar welded into the exhaust blow line at an angle to deflect cuttings downward into a container below. A short length of pipe is screwed ino the collar with a quick-shut valve attached. Desired samples can be collected by simply opening the valve. Sufficient air or gas will escape to vacate the trap. A sketch of

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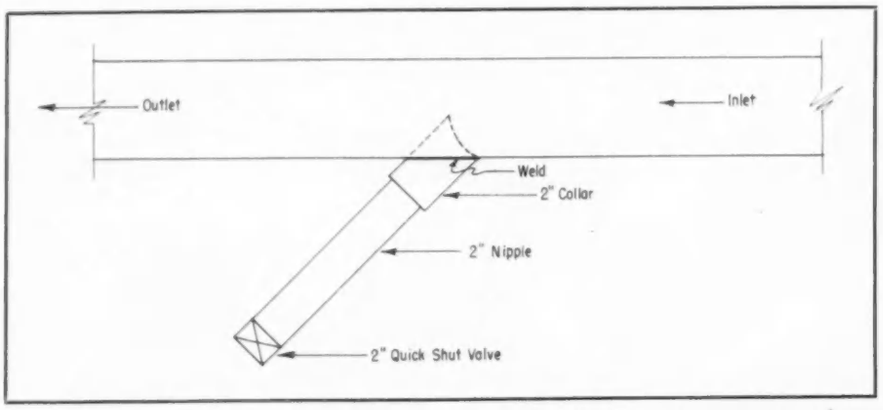

FIGURE 1—Side view of a simple trap for air or gas drilled formation samples. It may consist of a collar welded into the exhaust blow line at an angle to deflect cuttings downward into a container below. A short length of pipe screwed into the collar, with a quick-shut valve attached at the end, serves to collect samples. When the valve is opened, enough air or gas will escape to vacate the trap.

this type trap is shown in Figure 1.

A more elaborate sample trap is described by La Padre[2] (Figure 2), incorporating an adjustable baffle with a control arm to deflect incoming samples downward and simultaneously opening a valve through which samples pass and are collected. This type of trap is recommended for gas drilling, as heat from flaring gas prohibits collection of samples at the end of the blooey line.

A very effective sample collection device for use in air drilling is shown in Figure 3. This is a sheet iron plate placed directly in front of the exhaust blow line and tilted at an angle to deflect cuttings into a container placed below. The exact distance for the most effective sample collection is determined by trial and error and varies with the volume and velocity of air returning. The use of this type trap will usually recover only the heavier, larger samples.

SAMPLE DESCRIPTION

Conglomerates and Breccias. The successful drilling of conglomerates and breccias with air or gas depends upon the degree of consolidation of the formation. Unconsolidated gravels and breccias tend to erode severely with resulting caving and hole damage. Such deformation often renders air and gas drilling impractical, particularly if formation thickness is of significant magnitude.

Where the cementing matter of this type of formation has sufficient strength to withstand turbulence occuring at the bit, air and gas drilling is economically advantageous. Roundness and angularity of the components of conglomerates usually are retained in samples with a minimum of damage. Matrix materials are returned to the surface as fine dust, and chemical analysis is suggested for their identification if desired. Systematic analysis of the coarse clastics may be carried out using conventional techniques.

Sandstones. Although sandstone formations are readily identified in sample returns, care must be exercised in identifying the cementing material. Binocular description of sandstones has been found accurate in most cases, including color, and grain size and shape. In formations having a siliceous matrix, some surface textures are altered by bit action and by impact during movement to the surface.

Softer cementing materials are more difficult to identify since they are usually in the form of very fine dust at the surface. However, simple tests available to the wellsite geologist can be used to advantage in their identification. Calcareous and dolomitic matrices are determined by their relative effervescence in cold dilute acid and/or by the Fairbanks Method.[1]

Carbonaceous material, iron minerals, anhydrite, gypsum and clays can be identified by their color and texture.

Detailed studies of arenaceous rock types usually include grain fabric and composition, porosity and permeability determinations, and the character and composition of cementing materials. It is suggested that cores be taken from desired formations to obtain the best evaluation of sandstone.

Silts, shales, and mudstones. As these formations represent the finest-grained clastic materials, little is lost by deformation during drilling except structural features and hardness. Color and composition are accurately determined by binocular examination.

Identification of clays that are apt to swell on contact with water or water based drilling fluids may be easily determined in air or gas drilled samples. This identification may be facilitated by wetting the sample and observing any water absorption and swelling under the microscope. Laboratory studies of these formations are seldom affected by fragment size of samples. If this type sediment is an

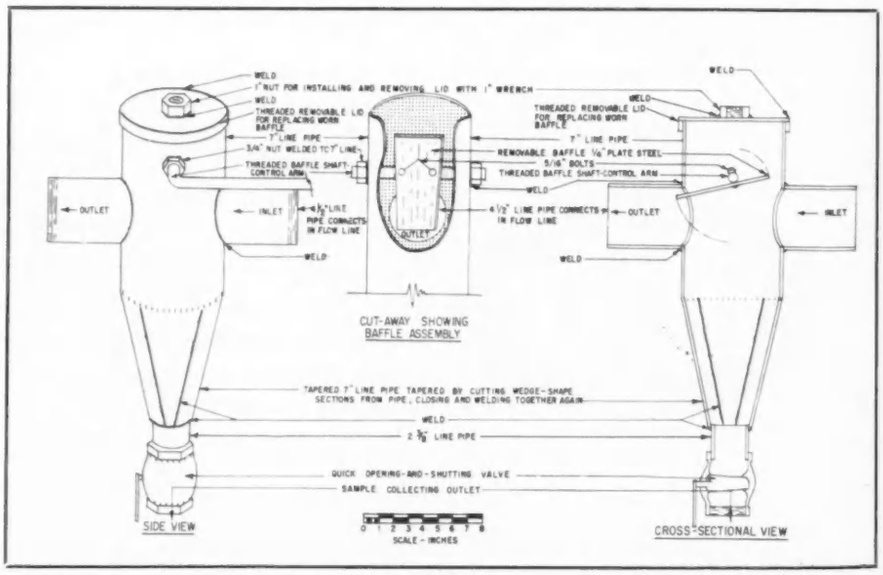
WELD
1" NUT FOR INSTALLING AND REMOVING LID WITH 1" WRENCH
THREADED REMOVABLE LID FOR REPLACING WORN BAFFLE
7" LINE PIPE
3/4" NUT WELDED TO 7" LINE
THREADED BAFFLE SHAFT-CONTROL ARM
REMOVABLE BAFFLE 1/8" PLATE STEEL
5/16" BOLTS
OUTLET
INLET
4 1/2" LINE PIPE CONNECTS IN FLOW LINE
CUT-AWAY SHOWING BAFFLE ASSEMBLY
TAPERED 7" LINE PIPE TAPERED BY CUTTING WEDGE-SHAPE SECTIONS FROM PIPE, CLOSING AND WELDING TOGETHER AGAIN
2 3/8" LINE PIPE
QUICK OPENING-AND-SHUTTING VALVE
SAMPLE COLLECTING OUTLET
SIDE VIEW
CROSS-SECTIONAL VIEW
SCALE - INCHES

FIGURE 2—This is a more elaborate sample trap, previously described by La Prade. It incorporates an adjustable baffle with a control arm to deflect incoming samples downward, simultaneously opening a valve through which samples pass and are collected. This type is recommended for gas drilling, since heat from flaring gas prohibits collection of samples at the end of the blooey line.

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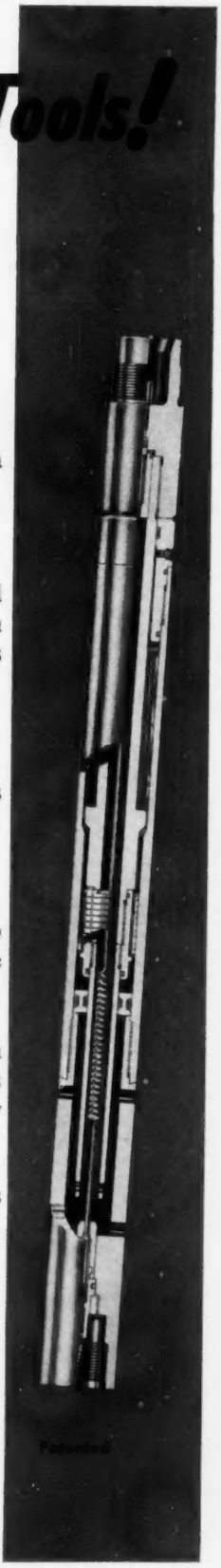

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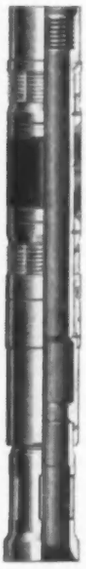

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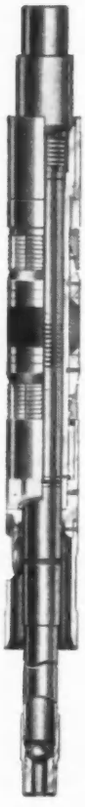

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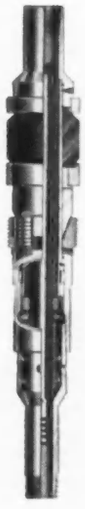

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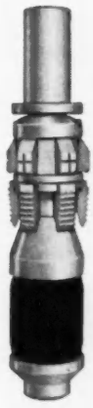

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oil pay exhibiting high porosity and low permeability, it is possible to drill through it without loss of sample returns.

Limestone and dolomite. Probably more detailed information is lost in drilling carbonates with air or gas than any other type of sediment. Color is readily apparent, but crystallinity, laminae, oolites, fractures, vugs, some microfossils and inclusions are ordinarily destroyed by attrition and impact. Carbonate samples are usually finer than other types of air or gas drilled sediments unless the formation is extremely porous. Slowed penetration rates may accompany the drilling of dense carbonates. It is suggested that particular attention be paid to drilling time through these formations, drilling breaks being the geologist's best indication of porosity and permeability.

Evaporites. Salt, anhydrites and gypsum (the more commonly occurring evaporites) are easily detected from associated shales, but are somewhat difficult to differentiate visually from fine-grained, angular sands which may occur in an evaporite section. Again the geologist will find drilling time useful in identifying the sequence of evaporite beds encountered. Should specific examinations of certain evaporites be desired, coring is recommended.

Miscellaneous rock types. The geologist will encounter cherts and flints more often than most other rock types under this category.

Chert samples drilled with air or gas possess the same characteristics as those drilled with fluid. Particle size is diminished, but identification is readily facilitated by the use of higher magnification, usually 30 to 40 times particle diameter.

Glauconite, valuable in correlation and indicative of depositional environment, is characterized by its pale green to greenish-black color. Unfortunately, glauconite occurring with shales is often obscured by the fine shale particles and may be overlooked in sample running. This omission is less frequent when glauconite is found with sandstones and carbonates.

Pyrite retains its characteristic color and metallic sheen in samples from air and gas drilling.

MECHANICAL AIDS

Drilling time. Since air or gas penetration rates are usually greater than those of fluid drilling, 8- or even 4-hour drilling time clocks are recommended to determine drilling breaks graphically. Drilling breaks previously established during fluid drilling are reflected with air or gas often with better definition, bit weight being constant.

Drilling practice is usually dictated by hole conditions, such as sloughing or deviation. Penetration rates may be correspondingly reduced in soft formations or relatively increased in hard formations. Similarly, sample size is not determined entirely by penetration rates or by type of lithology—rather, by a combination of these factors, and air or gas volumes.

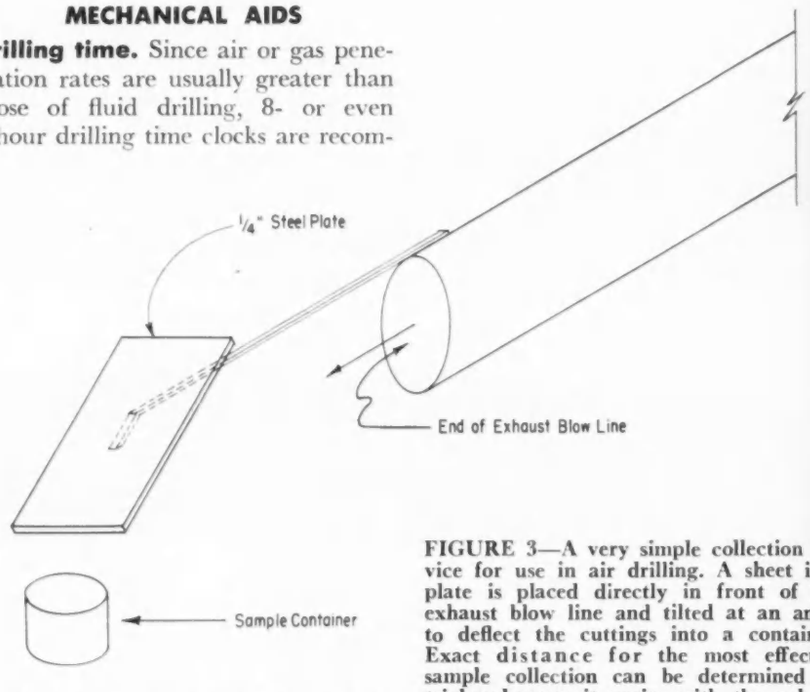

FIGURE 3—A very simple collection device for use in air drilling. A sheet iron plate is placed directly in front of the exhaust blow line and tilted at an angle to deflect the cuttings into a container. Exact distance for the most effective sample collection can be determined by trial-and-error; it varies with the volume and velocity of air returning. Use of this type of trap results usually in recovery of the heavier, larger samples only.

Continuous gas analyzers. The presence of combustible gases in the return circulation system is easily accomplished by the use of gas indicators, chromatographs and other instruments. These devices are useful in determining small gas shows. If gas shows are encountered they are immediately known at the surface, sometimes before ignition at the end of the exhaust blow line.

Continuous gas analysis is useful during gas drilling, a gas show being indicated by change in gas content. Input volume of drilling gas, constantly compared to return volume is useful in determining gas shows; however, instrumentation of this device is still in the experimental stage.

Drilling programs. Since air and gas has been recognized as an economical drilling technique, geologists are being asked to determine intervals which may be successfully drilled with air or gas. This has created the need for close liaison between geologists and drilling engineers in evaluating the economics of a proposed location.

About the Author

H. Fred Downs specializes in geological problems associated with air and gas drilling. He joined Technical Drilling Service, Inc., Midland, Texas, in 1958. Downs holds B.S. and M.S. degrees in geology from the University of Arkansas. Before joining Technical Drilling Service he worked in the Geological Department of Gulf Oil Corporation in West Texas for about three years. His career also includes about four years of service in the United States Navy.

ACKNOWLEDGMENT

The author gratefully acknowledges the many geologists who have contributed to this article by their comments on air and gas drilling.

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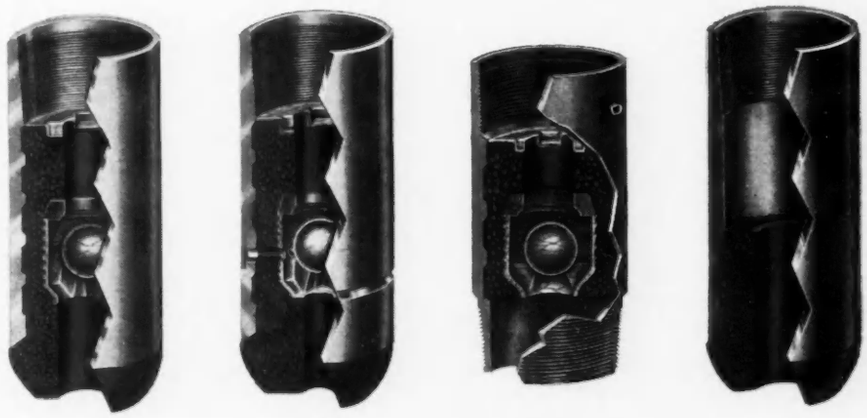

FIG. 302 FIG. 322 FIG. 401 M&F FIG. 202

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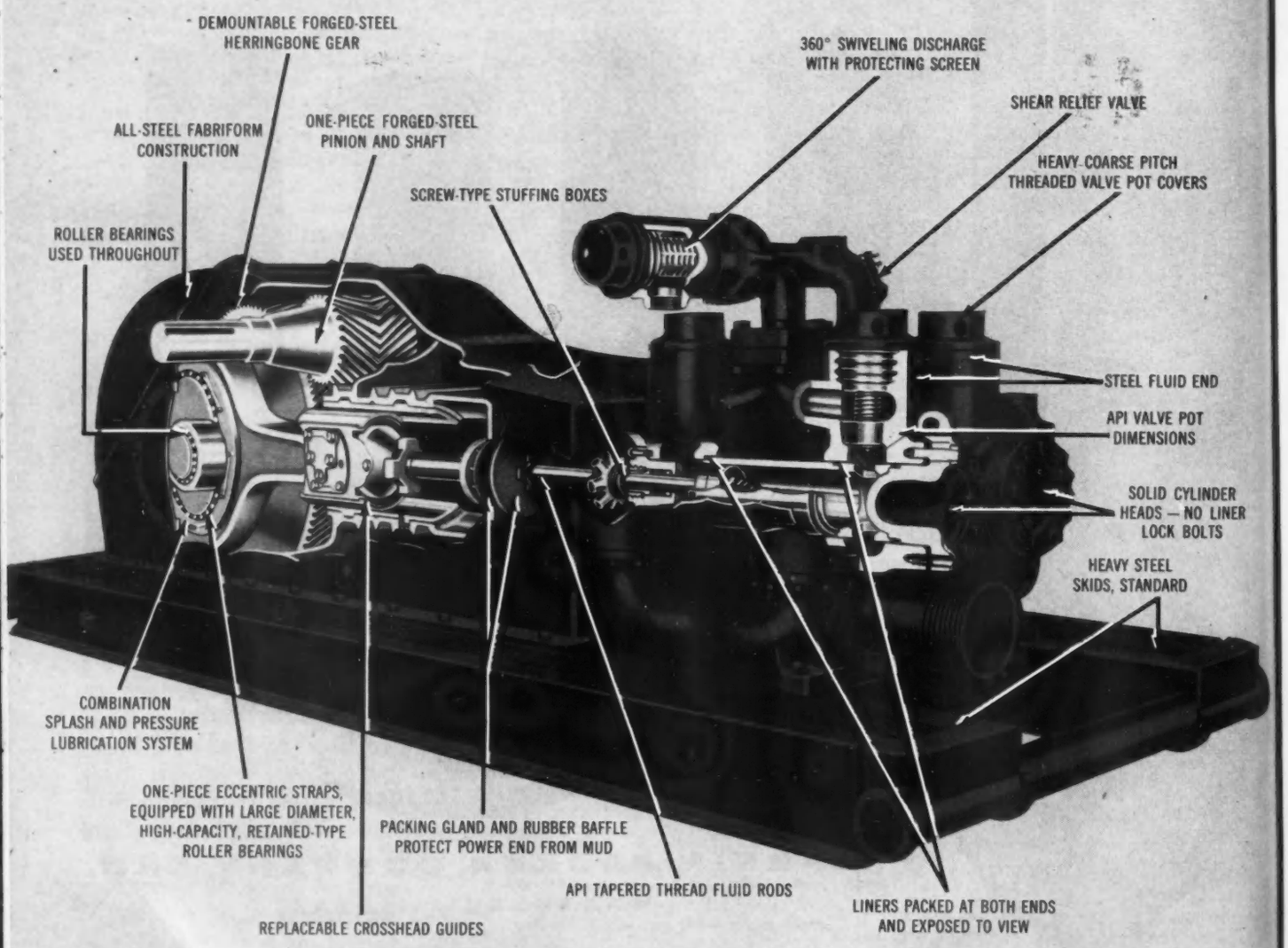
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SOLID CYLINDER HEADS — NO LINER LOCK BOLTS
HEAVY STEEL SKIDS, STANDARD
COMBINATION SPLASH AND PRESSURE LUBRICATION SYSTEM
ONE-PIECE ECCENTRIC STRAPS, EQUIPPED WITH LARGE DIAMETER, HIGH-CAPACITY, RETAINED-TYPE ROLLER BEARINGS
PACKING GLAND AND RUBBER BAFFLE PROTECT POWER END FROM MUD
API TAPERED THREAD FLUID RODS
LINERS PACKED AT BOTH ENDS AND EXPOSED TO VIEW
REPLACEABLE CROSSHEAD GUIDES

POWER END DESIGN

In place of bulky steel castings, a smooth, easy to handle steel fabriform frame is used. Fabriform construction allows critical stress areas to be reinforced scientifically, and it is as strong, yet lighter than castings. The massive main gear, of wear-resisting heat-treated forged steel, is designed to handle the highest of mud pressures. It is matched with a long-wearing, heat-treated forged-steel pinion, machined integrally with its shaft. Roller bearings, used throughout, reduce power loads and eliminate need for bearing adjustment. Crosshead guides (slippers in larger pumps) can be replaced for added years of pumping.

FLUID END DESIGN

Steel castings are electrically welded into compact fluid ends to handle the highest of mud pressures. Suction passages are large, direct and smoothly curved to speed fluid flow, even when pumping heavy muds. Use of one suction eliminates *dead spaces* which tend to restrict flow. A separate pot for each valve provides easy access to valve chambers. Screw-type valve-pot covers speed valve replacement. Patented "exposed" liner construction prevents costly washouts and damage to liner or fluid ends, because leaks can be spotted and packing tightened before damage occurs. Screw-type stuffing box glands apply an even pressure for packing and eliminate uneven packing wear and scoring of piston rods.

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VOLUME
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PRESSURE
..5¼" (Minimum) Liner Size—2,954 psi

D-700

MAXIMUM INPUT
..700 hp @ 65 spm
VOLUME
..8¼" (Maximum) Size Liner—909 gpm
PRESSURE
..5½" (Minimum) Size Liner—2,727 psi

D-550

MAXIMUM INPUT
..550 hp @ 65 spm
VOLUME
..7½" (Maximum) Liner Size—751 gpm
PRESSURE
..4¾" (Minimum) Liner Size—2,815 psi

D-375

MAXIMUM INPUT
..375 hp @ 70 spm.
VOLUME
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PRESSURE
..4¾" (Minimum) Liner Size—1,931 psi

D-225

MAXIMUM INPUT
..225 hp @ 70 spm
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PRESSURE
..4¼" (Minimum) Liner Size—1,551 psi

D-125

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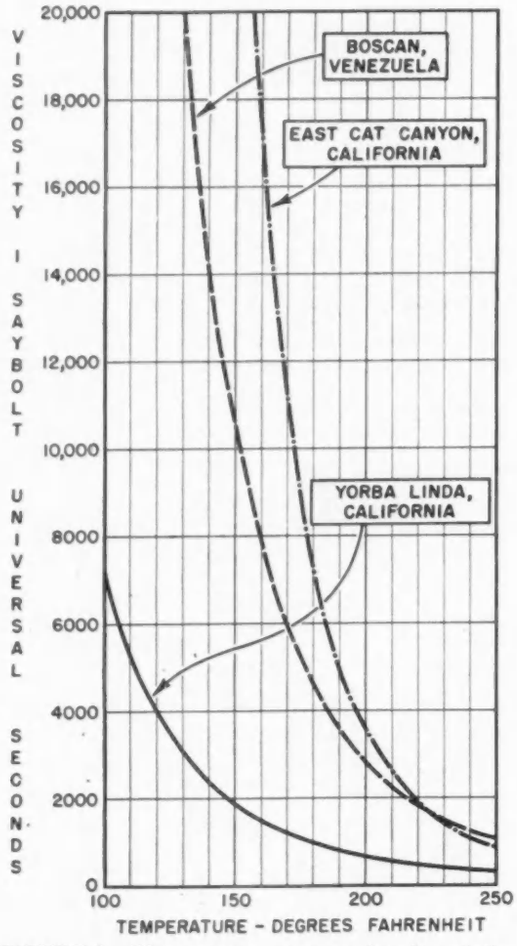

FIGURE 1—These are temperature-viscosity relationships for three heavy crudes. Note that the curves tend to level off at increased temperatures and that additional heat then has little effect in further reducing viscosity.

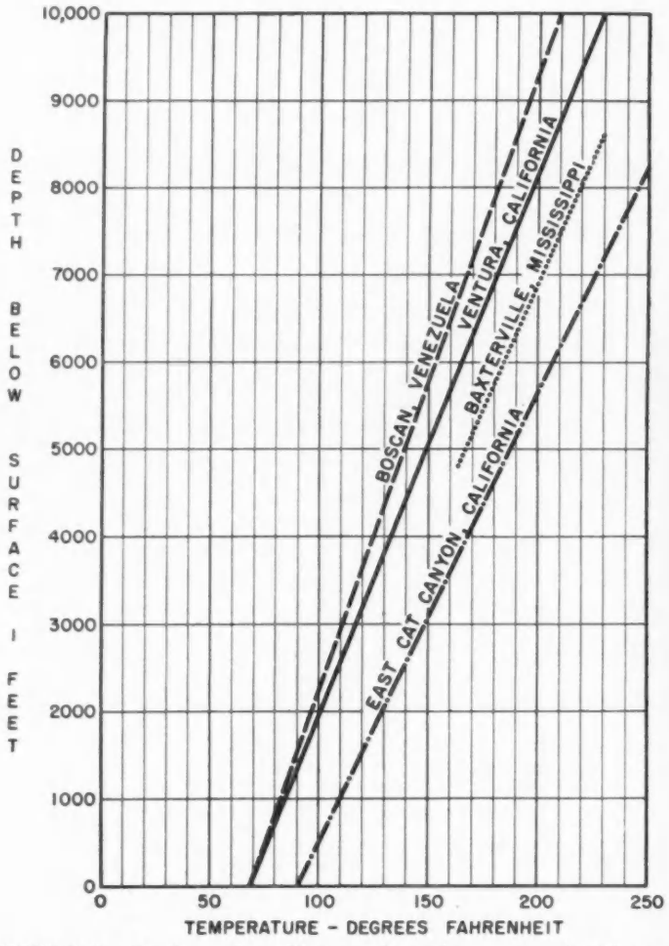

FIGURE 2—Geothermal gradients such as these are used with temperature-viscosity relationships to determine the feasibility of down-hole heating.

Down-hole heating, proper pumping techniques and correct treating methods will reduce operating costs and increase production when . . .

Producing low gravity, viscous crude

By E. W. Walker, Division Mechanical Engineer
Western Gulf Oil Co., Los Angeles

ECONOMIC PRODUCTION of heavy crude (15 gravity and below) is a challenge to most operators since potential recoverability, with present methods, often is low. However, proper application of equipment, correct selection of facilities, use of waste heat, use of insulation and prudent operating techniques can save money and lower operating costs. This article deals specifically with:

- Promoting heavy crude flow to the well bore.
- Artificial lift of wells producing heavy crude.
- Proper treating procedures for heavy crude.

Most low gravity crude production problems are due to the highly viscous nature of such oil at low temperatures. Many heavy crude deposits are found at relatively shallow depths

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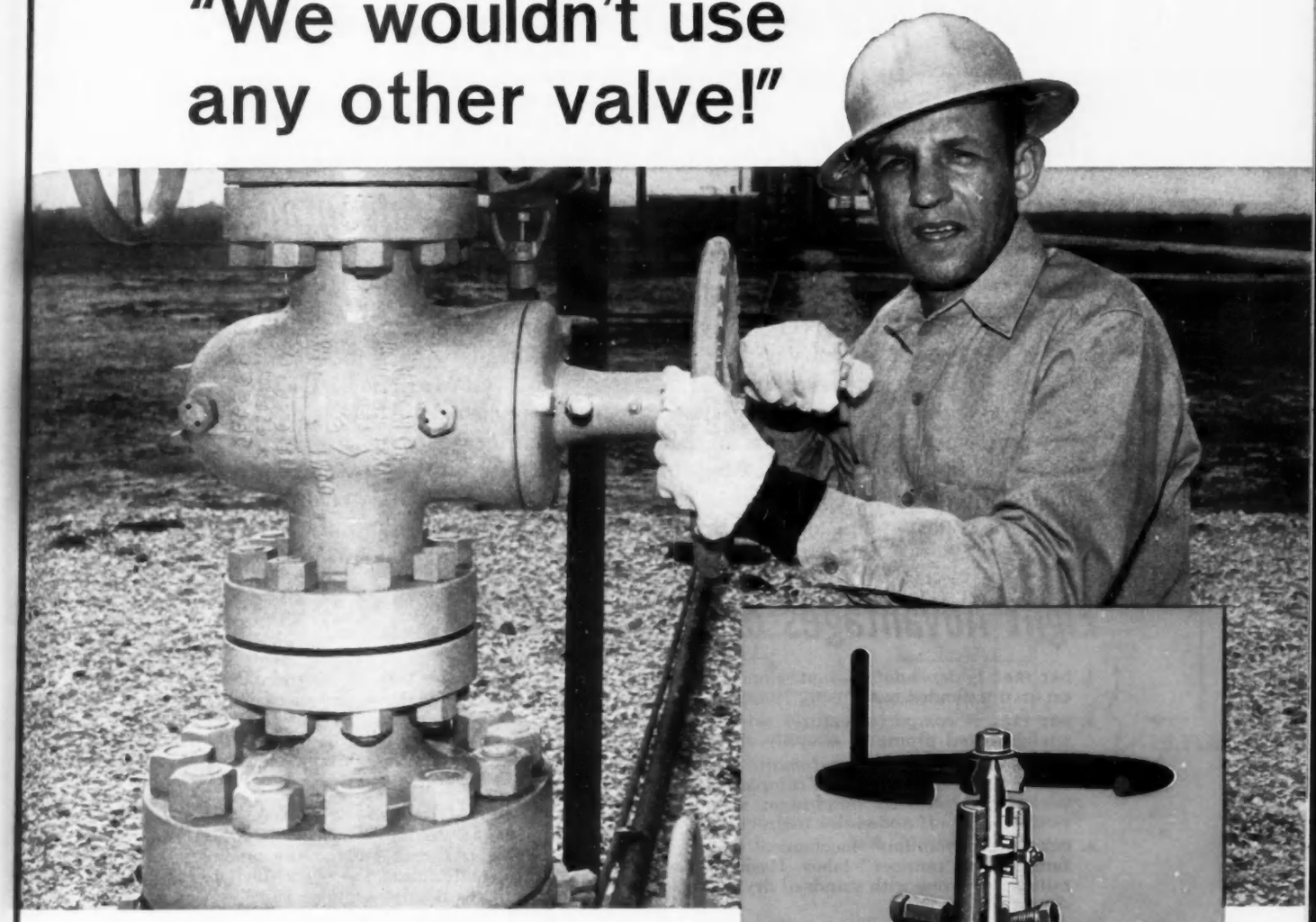

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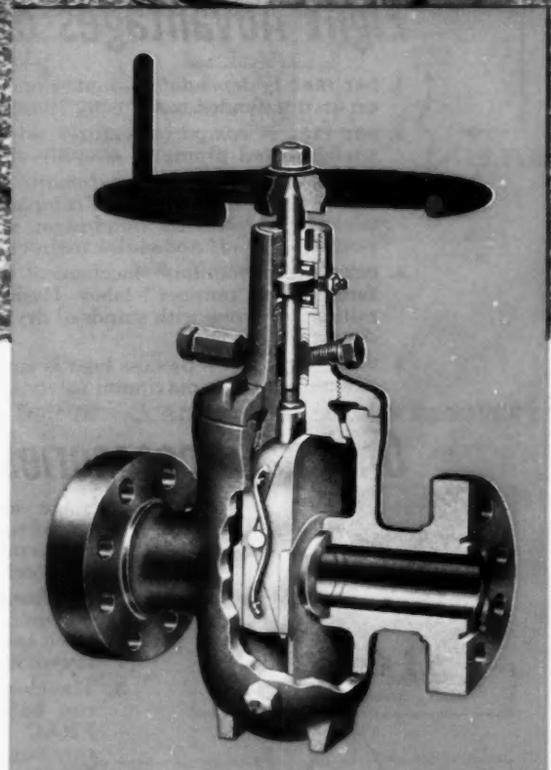

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3. **DRY FRAC** is *completely automatic*—controlling instruments are mounted in a compact panel for convenience. Motorized diaphragm valves result in positive shut-off and easier maintenance.
4. **DRY FRAC** is *familiar*—mechanical components are familiar to "pumper" labor. Basic process is familiar to anyone with standard dry desiccant dehydrator experience.
5. **DRY FRAC** is *safe*—process heat is supplied by an indirect heater for maximum safety.
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8. **DRY FRAC** can be *waterless*—system can usually be designed to operate without the need for water.

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5. DRY FRAC can be designed for water or air cooling.
6. When closed cycle regeneration is selected, the blower may be powered by electricity, gas engine or main gas, as the customer prefers.
7. When closed cycle regeneration is selected, open cycle regeneration may be added to the system for standby service with the addition of other control equipment. The system may be controlled to switch to open cycle operation automatically in the event the blower stops.
8. All control systems include a safety feature to prevent switching into a bed not sufficiently cooled, which would cause excessively hot gas to enter the pipeline.

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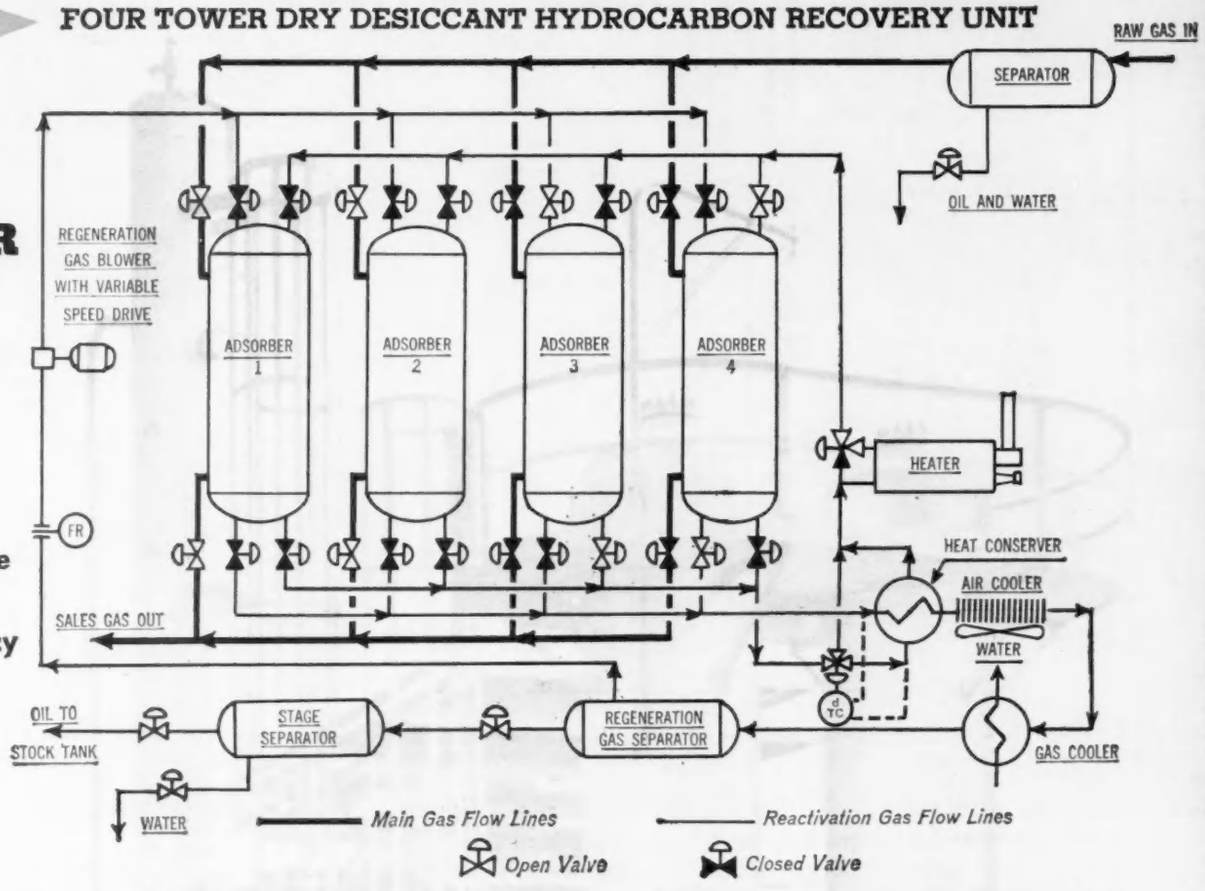

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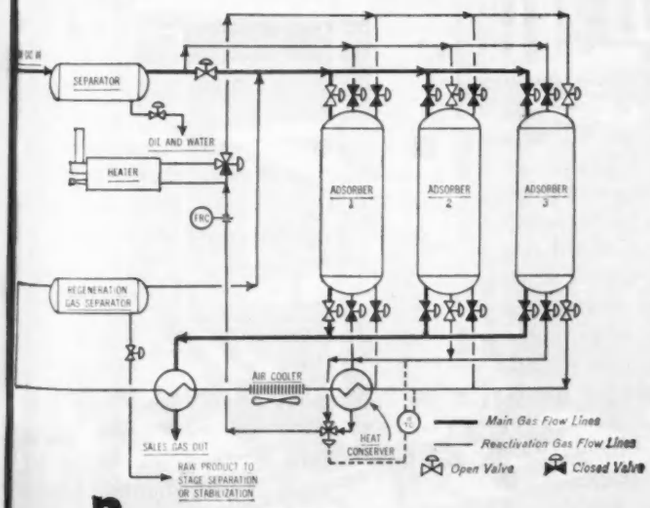

3 TOWER

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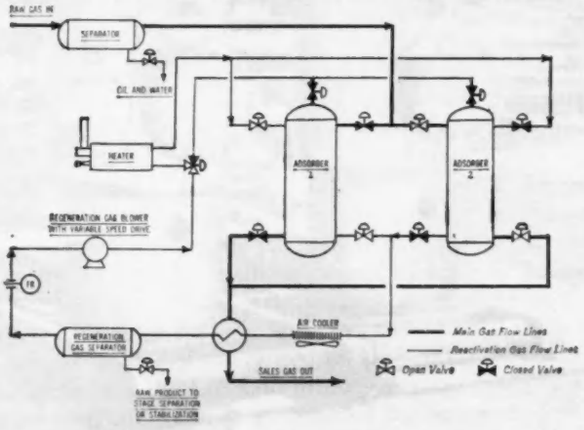

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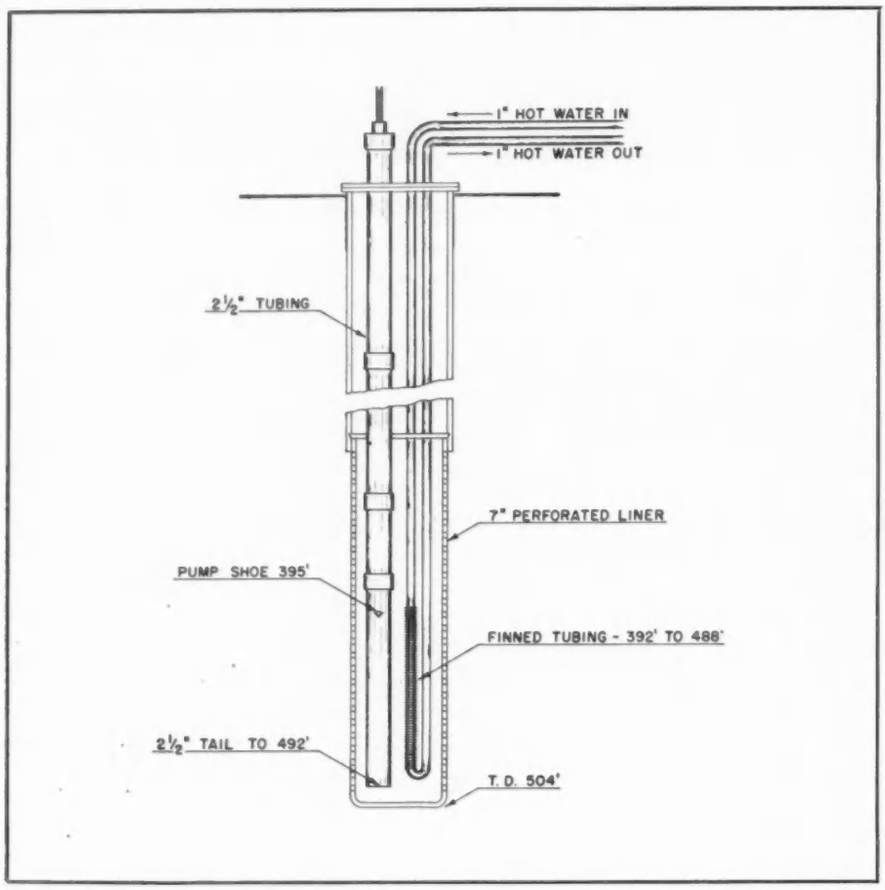


FIGURE 3—Closed circulating hot water heating systems such as this are typical of those used in shallow California wells which produce low gravity crude.

where low reservoir temperature and little if any natural driving force exists to produce flow.

Heaters. Figure 1 shows typical viscosity-temperature relationships of some heavy crudes. These curves show how the effect of increasing temperature produces less and less change in viscosity. Figure 2 shows a typical relationship of earth temperature with depth for several low gravity crude producing fields. Such curves, when prepared for a heavy crude oil reservoir, will indicate whether down-hole heating can be expected to yield increased production.

For example, a shallow (600-foot) Yorba Linda well producing 12.8 gravity, 45,000 SSU viscosity crude at a reservoir temperature of 85° F, would be expected to produce better if heated. A temperature increase of 140° F. will reduce viscosity to about 1/60th of its original value.

On the other hand, an 8,600-foot Baxterville, Mississippi, well producing 13 gravity, 80 SSU viscosity crude at a reservoir temperature of 229° F, could hardly be expected to yield extra production with further heating. In this case, the problem would be to design the pumping and gathering system to retain as much reservoir heat as possible.

Under Yorba Linda type conditions, downhole heating has proved very successful. It is estimated that in California alone, over 1,700 heating installations now are in use. A typical installation is shown in Figure 3.

Since viscosity increases rapidly with loss of temperature, all economic means should be used to retain natural well bore temperatures or those induced by heaters. Improvements in operation and savings in pumping, gathering and treating costs all add up to pay out extra costs for insulation.

In general, well heating is most likely to be attractive in shallow wells producing 15 gravity or heavier oil. On wells of this kind in California, the average increase in production has been from 10 to 20 bpd, and heater payouts vary from three months up. Several large operators believe optimum results are obtained when heaters maintain 150° to 190° F on the well fluid. Higher temperatures do not always result in higher sustained production rates, but substantially higher temperatures can result in coking, scaling and other troubles.

Running sand has been a problem in many heavy crude areas. Gravel packing is the most accepted method of control. With the advent of well heating, some operators have been able to control sand production by reducing liner slot size to about 0.03 inches. Control of sand without impairing production is a very real problem in many heavy crude producing areas.

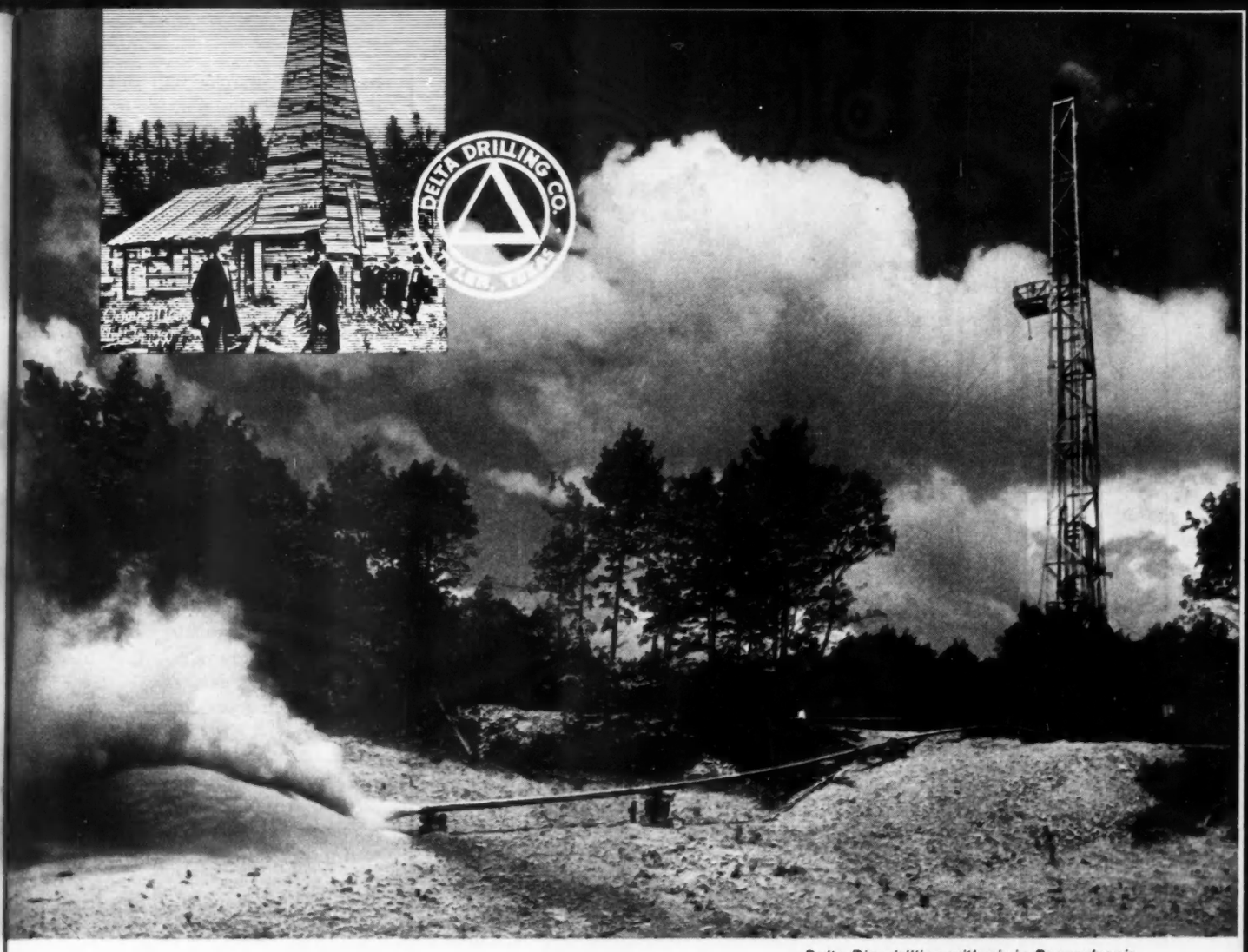
In-situ combustion. A different and more aggressive method for increasing heavy crude recovery is receiving attention.[4] This is the burning of oil in the reservoir to produce heat and pressure to drive reservoir fluid to well bores.

So far, the experiments have been encouraging but costs and high temperature corrosion problems have prevented rapid acceptance. Ultimate recoveries can be high in the proper type of reservoir. The method has been proven possible, now costs must be reduced to a practical point.

The most appealing aspect of this method is its ability to recover a high percentage of the oil from a reservoir in a relatively short time. Proper solution of cost and corrosion problems could yield big returns.

Lifting heavy crudes. Some heavy crude wells will flow, but the majority usually require some type of artificial lift.

In Eastern Venezuela, a major operator is gas lifting three heavy crude producing wells. The best of the three produced initially 1,400 bpd of 10.5 gravity crude from a 100-foot sand at 7,700 feet through 3-inch tubing. Injection gas pressure was 1,800 psi. The injected GOR varied from 2,500-3,000 cubic feet per barrel. The well is producing through an 8-inch flow line, 3,300 feet in length. There is only negligible pressure drop in the flow line. Wellhead temperature is about 110° F. Separator pressure was varied from 0-500 psi, with no apparent effect on production rate or injection GOR. To date, the well has produced 380,000 barrels and now is producing 500



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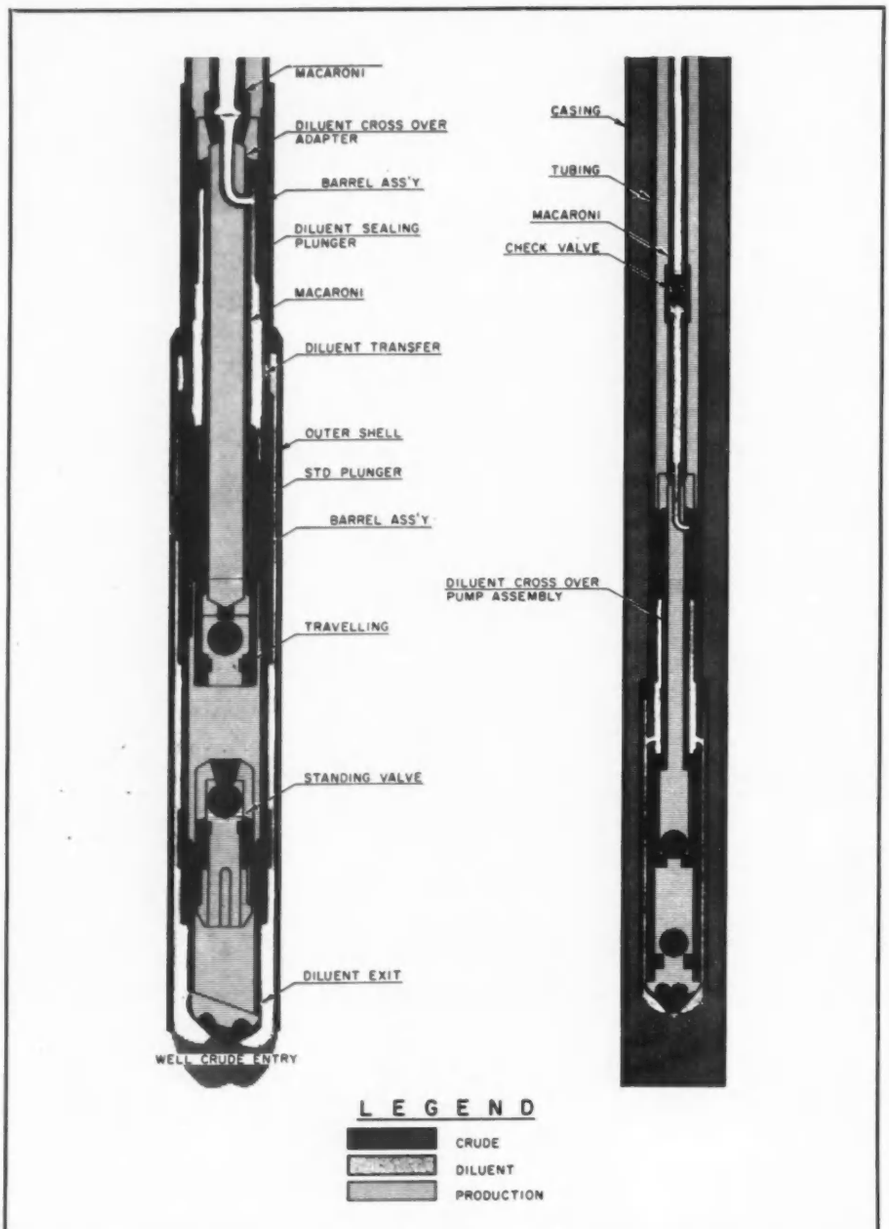

FIGURE 4—This diluent crossover pump installation has been successful in reducing heavy crude pumping problems. Diluent is introduced down the hollow rod or macaroni string and exits below the pump where it mixes with the low gravity, produced crude.

bpd with 20 percent water, using 1,500 psi gas.

The poorest of the three wells had an initial production of 400 bpd using 1,200 psi injection gas. Injection GOR was 4,000 cubic feet per barrel. This well has produced 170,000 barrels and still is producing 370 bpd of clean oil.

The same operator is experimenting with subsurface hydraulic units. The power oil, a light gravity blend oil, is pumped to the wells through 2-inch lines and is introduced down tubing to operate the subsurface hydraulic pump. Power oil exhausts into the tubing-casing annulus above a hook wall packer, where it mixes with produced oil and returns to the surface.

Pumping. Rod pumps are used widely in lifting heavy crude. Problems encountered usually are due to high viscosities, sand and corrosion.

Where sand and high viscosity exist, plunger fits usually are:

1. Close to create wiping action which will prevent any sand from getting between barrel and plunger.

2. Wide to assure that any abrasive particles which might get between barrel and plunger will slip by without causing the plunger to stick or gall. Choice of plunger tolerance depends on well or field characteristics, pump type, fluid temperature, stroke and speed.

To obtain maximum fluid passage through the pump, ball valves must function properly. Early in the history of pumping crudes, it was found that the small clearance of 0.04 to 0.05 inches between the ball and the guides in the cage, resulted in the ball hanging up in the cage. This resulted in loss of effective pump stroke. The difficulty was corrected by using small balls in all valves pumping viscous fluids. In addition, modifications were made in the ball cage. The guide surface presented to the ball was reduced to almost a line on each guide. A further modification was to provide a stop to keep ball lift to a minimum, thus assuring positive acting valves.

These changes in ball size and cage design increased production from many wells as much as 10 times over previous rates. They have been particularly effective where sand is present in viscous crudes.

Another effort to improve ball valve action has been development of a rod "puncher" which pushes against the standing valve ball on the downstroke to assure the valve closing. The upper end of the rod pushes the traveling valve ball off its seat on the upstroke and provides positive valve opening.

Pump types uses for viscous fluids are:

- Tubing liner pump—allows largest possible bore and valve size in relation to tubing size.
- Rod liner pump with top hold down—allows fluid to wash directly over the seating device area. This prevents sand accumulation above the pump barrel.
- Rod liner pump with traveling barrel—provides constant fluid agitation around outside of pump barrel. This pump has the traveling valve at the upper end of the pump assembly which prevents sand from settling inside the pump barrel.
- Tubing liner and rod liner pump using a short barrel with long plunger and extremely close tolerance—continuous wiping action is provided. The short liner barrel precludes the possibility of a tight fit, causing stroke loss due to frictional drag.
- Tubing liner pump equipped with

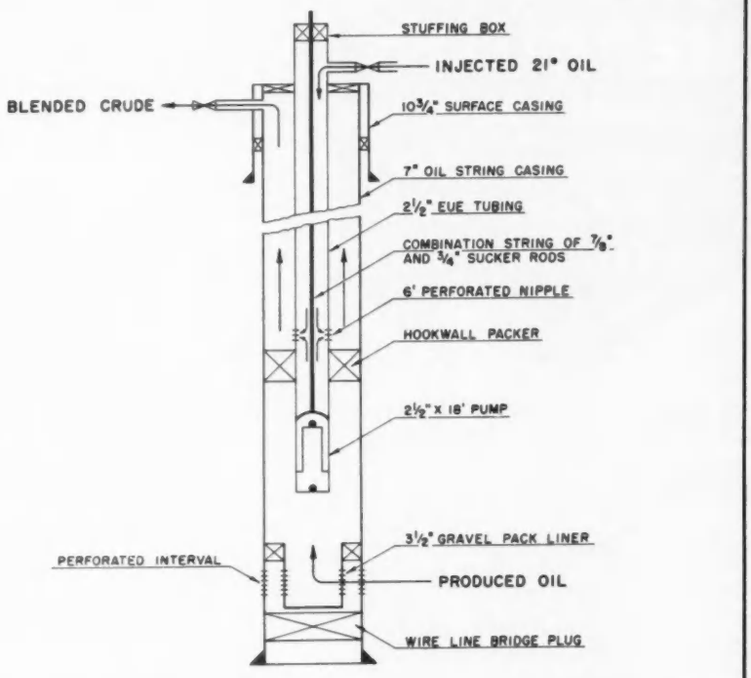

FIGURE 5—Here is a hookup for annulus pumping of diluent blended heavy crude. A 21-gravity oil is injected down the tubing and is mixed with the heavy produced crude at the perforated nipple located just above the pump. The blend is then pumped to surface through the tubing-casing annulus.

the rod "puncher" assembly—positive valve action is assured.

Hollow rod pumping (for production or diluent injection) usually is used when other methods have proven uneconomical or impossible.

Production moves up the macaroni tubing, or hollow rods at an increased velocity and keeps sand moving. Abrasive well fluids never reach the upper or pickup end of the pump, thus preventing sticking, regardless of sand cut. The pump plunger is lubricated from clean oil in the annulus between the tubing and the hollow rods. In extreme sand conditions, a tail pump is installed at the surface to operate in conjunction with a circulating valve installed in the hollow rods directly above the pump plunger. This provides fluid circulation in the hollow rods during the upstroke cycle and assures continuous fluid through the rods.

For diluent injection, a cross over (Figure 4) is used which transfers the diluent around the pump shell and releases it in the well fluid directly below the pump intake. This method is more often used for producing extremely viscous fluids, than for handling sand.

Units. Pumping units of all types and sizes are used for heavy oil pumping, depending on requirements.

Short stroke hydraulic units are being used on many shallow, low volume wells. These smaller units are not counterbalanced and rods drop as fast as fluid will allow. The upstroke can be controlled by regulating the speed of the hydraulic pump. If well fluid cools in the tubing or if production cools in the flow lines, these units will apply and retain maximum hydraulic system pressure under the cylinder until a stroke occurs. The unit then will reverse and another stroke will begin.

Large air balanced beam units and large counterbalanced, long stroke, hydraulic units also are commonly used to lift deep wells producing large volumes of low gravity crude. These units provide a long stroke, slow speed and readily adjustable counterbalance. Some hydraulic units automatically slow down and begin a gradual pull on the rods if well fluid congeals in the tubing. This feature is desirable when stroking after shut down. Also, beam units have been equipped with a separate gear box which per-

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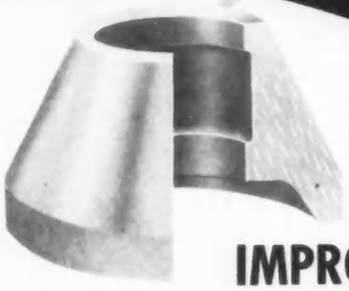

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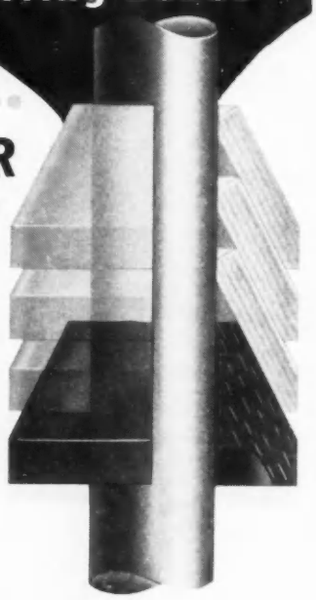

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Diluents. An ideal solution to viscous crude production is to reduce the viscosity by use of a diluent since this treatment reduces both well pumping and treating problems. Sometimes this is the only feasible solution. However, whether this is economic depends on many things, especially the availability of the diluent.

In Eastern Venezuela, one major operator is producing heavy crude by mixing 21-22 gravity crude with 10-12.5 gravity production to make a 15 gravity blend. This has proved successful since it reduces pumping, treating and shipping problems. Blending is done by pumping higher gravity crude down the tubing. Tubing is set on a hook wall packer and has a six-foot perforated nipple just above the packer.

Production is pumped from below the packer and commingles with the blend oil above the packer, both leaving the tubing through the perforated nipple. Total fluid is produced up the annulus between tubing and casing. This method has allowed a reduction in polish rod horsepower from 20.6 to 11.8 and peak torque from 278,000 to 144,000 inch-pounds with the same production rate. The procedure is well established and approximately 27,000 bpd now are produced in this manner (Figure 5).

In cases where well bore temperatures are high, it is good practice to retain the heat in the produced fluid. This can be done by maintaining a high flow velocity in the tubing and by burying and/or insulating flow lines. If down-the-hole heat already exists or is induced artificially, and can be retained during pumping and gathering, less additional heat will be required for treating. If this heat is not saved, additional heat will be required to treat the oil at the tank battery.

Treating heavy crudes. Heavy crudes present special treating problems. The specific gravity difference between heavy crudes and water is very small and the less this difference, the less the tendency for natural separation to occur. For this reason, most of these crudes can best be treated by methods which tend to increase this gravity difference and which reduce viscosity. Heat does both and usually

Well	BEFORE TREATMENT		AFTER KONTOL SQUEEZE TREATMENT	
	Tubing Failures Per Year	Iron Loss (Lbs/Day)	Tubing Failures Per Year	Iron Loss (Lbs/Day)
A	2	3.8	0	0.7
B	2	4.5	0	0.7
C	4	8.8	2	4.3
D	1	10.1	0	0.6
E	1.7	11.2	0	1.6
F	2	8.8	0	0.5
G	1.3	4.7	0	1.0
H	1.5	3.3	0	0.5
	15.5	55.4	2	9.9

another
TRETOLITE SERVICE
report

87% reduction
saves $52,000 annually

Squeeze Application of KONTOL*CORROSION INHIBITOR REDUCES TUBING FAILURES FROM 15.5 to 2 PER YEAR

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COST OF TREATMENT

The KONTOL squeeze treatment cost about 70 mills per barrel of produced oil and 1.9 mills per barrel of fluid produced. This resulted in a treating cost of 17 mills per barrel less than previous corrosion prevention methods.

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is employed to aid separation, whether it be in an electrostatic or chemical treating system.

As the temperature of the production is increased, the viscosity of the oil decreases. At the same time, the oil density decreases while the water density remains practically unchanged. However, the differential between the two is increased, thus aiding gravity separation.

In California, where wholesale gas prices are currently 23¢ per Mcf or higher, it is very desirable to conserve heating fuel. The use of more chemical and less heat is more often dictated than would be the case in an area where fuel values are lower. Reduced heat also results in less gravity and volume loss. The use of fiber board tank insulation has proven profitable and useful not only as a fuel saver but also as a means of improving the treating operation. Insulated tanks will retain heat longer than bare tanks, and will permit coalesced water to settle out faster. Often, bare tanks cool so rapidly that water becomes trapped in the viscous crude as it cools and good separation cannot be obtained. Also, if heat must be added in the settling tanks, convection currents hinder proper water settling.

Gas removal from foaming oil often can be accomplished by the use of silicone surface active anti-foam agents and by reducing the heated crude to atmospheric pressure. These chemicals are used in very small quantities and are best applied far back in the system for proper mixing. Their use often reduces friction pressure in the gathering system in addition to reducing foam.

The application of heat to heavy crude production deserves considerable attention. This is more important as fuel values rise. Care should be taken not to apply heat to large quantities of free water which often can be dropped out without heat. Rate of heat transfer direct to heavy crude is low, requiring much more heating surface than when heating water.

Sand and silt can foul up heat exchangers unless designed for self cleaning with high fluid velocities. Scale formation on heating surfaces soon can reduce heater efficiency. This usually can be prevented or retarded by chemical treatment.

Treating system. A typical heavy crude treating system, where fresh

water, sand and gas must be removed, might consist of a large tank to receive production from the production separator. This vessel should be equipped with heating coils (or some other means of heating) and a water bleed, so that free water can be drained off. Water cut oil is removed from the top of this tank through a floating suction and is transferred through extended-fin heat exchangers to raise the oil to a treating temperature, probably at or near 190° F.

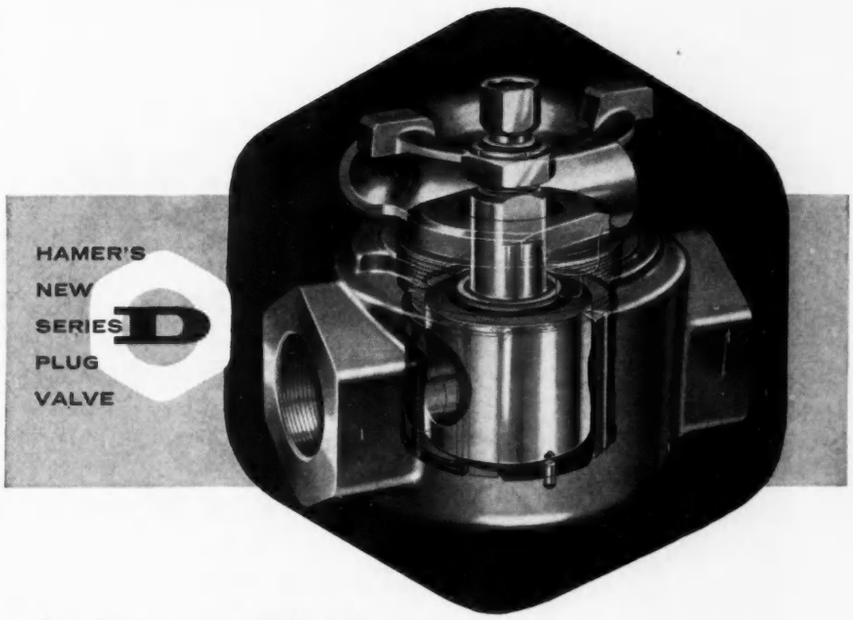
This heated oil then would go to an insulated wash tank or to an electrostatic treater, and finally to insulated storage tanks for shipment. Many variations of this arrangement can be found and often the choice of a system depends on characteristics of the crude being handled.

It is good practice to keep the oil moving continuously through the system, adding heat until treating is completed. Pipe line runs should be made continuously to take advantage of the elevated temperature and reduced viscosity.

Where rapid heating is desired, heat exchange in the water phase is preferred. Unbalanced arrangements of heating plates or coils will create turbulence and circulation. This will aid heating but often interferes with water settling. Coils placed close to the tank bottom usually keep the tank clean above them and allow solids such as silt or sand to accumulate below. If coils are elevated, it is not unusual for large quantities of waxes and B.S. to accumulate below the coil level. This usually results in more costly tank cleaning operations.

Heat exchangers consisting of finned pipe inside larger pipe are very effective when transferring heat to heavy crude. Exchangers should be operated at turbulent flow velocities and constructed to provide self cleaning, avoiding traps for the accumulation of silt and sand.

Water legs are effective for removing water from tanks that have a fixed overflow level and where a constant water oil interface is required; even when separating heavy crude from water where weight differentials are small. It must be remembered, however, that to have such a system operate properly, the temperature of the water leg must be maintained at



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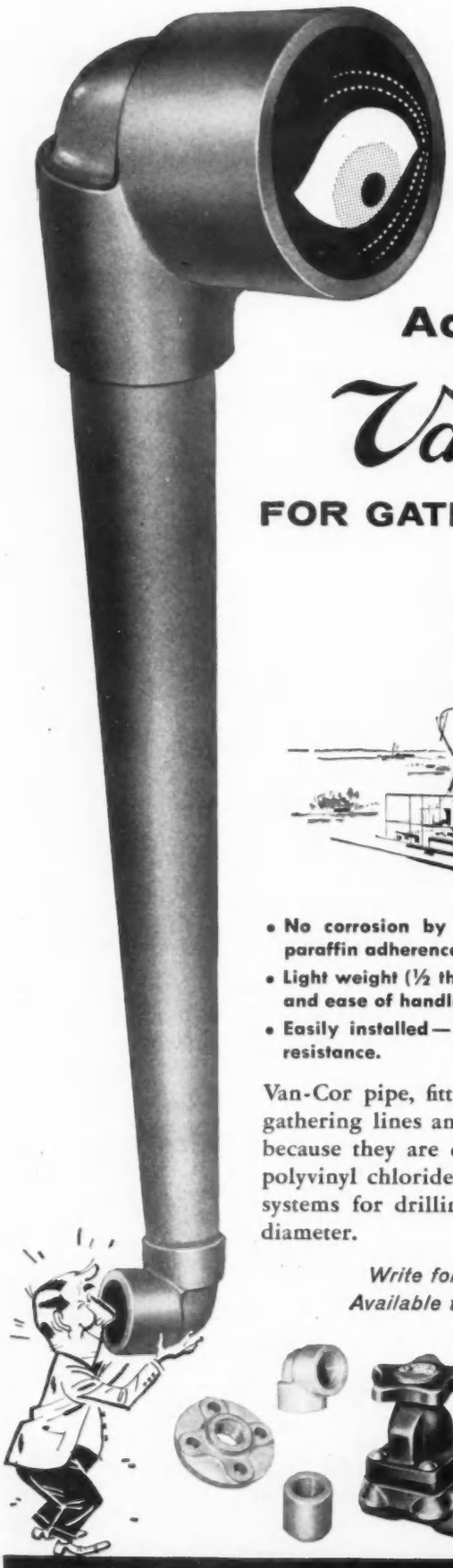

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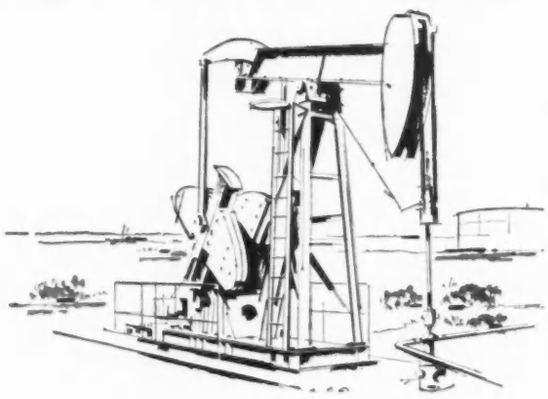

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About the Author

E. W. (Bill) Walker was graduated from Stanford in 1930, majoring in mechanical engineering. He spent a brief period with General Electric as test man in their engineering training program. His career in the oil business started with Shell Oil Company in Coalinga, Calif., in 1934. Later, he joined Kettleman North Dome Association and had charge of planning and constructing production facilities, including gas compressing stations. In 1943 he joined Western Gulf Oil Company in San Joaquin Valley and was transferred to the Los Angeles office as staff engineer where he has since been concerned with the mechanical aspects of drilling, producing and gas handling operations. He has been active in the California Natural Gasoline Association and served as its president during 1957. He is a registered professional engineer in California.

the same temperature as the fluid in the tank.

Often, an external water leg will cool and the density increase of the water in the leg will cause the level of the hot water in the tank to increase greatly before flow through the leg can start. A constant water oil interface level in tanks having variable fluid levels can be maintained by using a capacitance type sensing instrument.

This article is excerpted from a paper entitled "Heavy Crude Oil Production Problems," presented to the American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference in Houston, Sept. 20-23, 1959.

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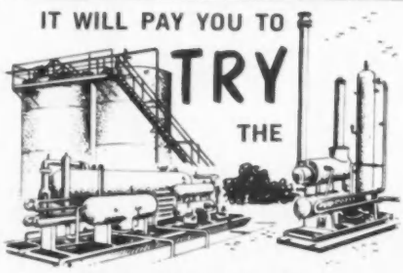

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Displacement methods for multiple tubing string wells

Proper selection of equipment and correct operating techniques can reduce completion time and job costs

By William W. Word, Jr.
Assistant Chief Engineer
The National Supply Company, Houston

AT PRESENT, operators use four general methods to displace drilling fluid from multiple tubing string wells on completion. Variations of these techniques also are used, depending on the type of wellhead and downhole equipment installed. The four general methods are:

- Swabbing
- Use of circulating valves or sleeves
- Single and multiple tubing string manipulation
- Use of hydraulic set packers.

Proper consideration of both surface and downhole equipment and correct operating techniques can eliminate many problems encountered in completing multiple wells.

A primary difference in single and multiple string completions is the method of displacing mud from the tubing after the string has been suspended within the wellhead and a means of pressure control installed. Since the use of a packer or packers is almost mandatory for dual producers, displacement presents problems similar to single string installations with a packer.

Multiple string displacement. Single completed wells with packers have been displaced successfully for years by using the stuffing box type tubing hanger as a means of controlling the well. The same control requirement for displacement exists on all multi-string installations; however, because of space limitations, the procedure is more involved.

Following are several displacement methods currently used for multiple string completions. Since the wellhead equipment, packer and accessory downhole equipment will, in some instances, limit the displacement methods which can be used, consideration should be given to these points in prewell planning and equipment specification.

Swabbing. After multiple tubing strings have been suspended and control equipment (christmas tree) installed, drilling fluid within the tubing can be removed by a conventional wireline swab. However, there is always a possibility of the swab getting stuck at some restriction within the tubing string to delay the completion. Because of time requirements, possibility of sticking, etc., swabbing is not ordinarily used for displacement in deeper wells.

Circulating sleeves or valves. Use of wireline actuated circulating de-

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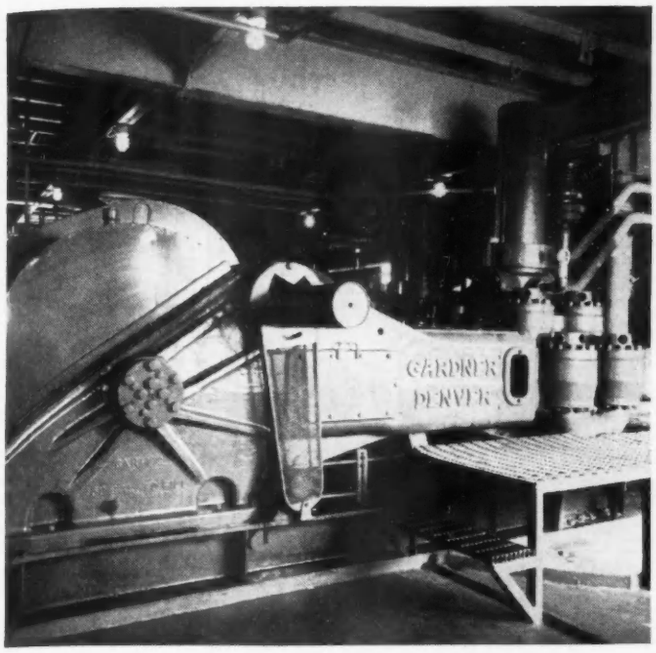

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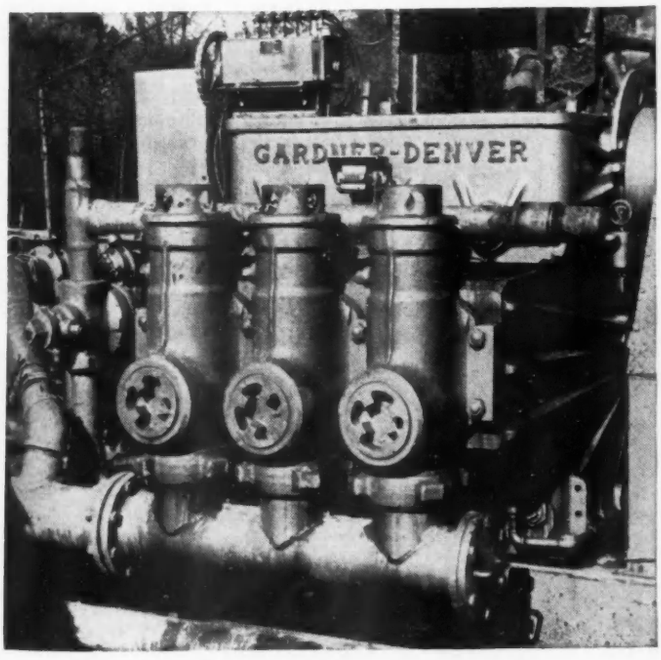

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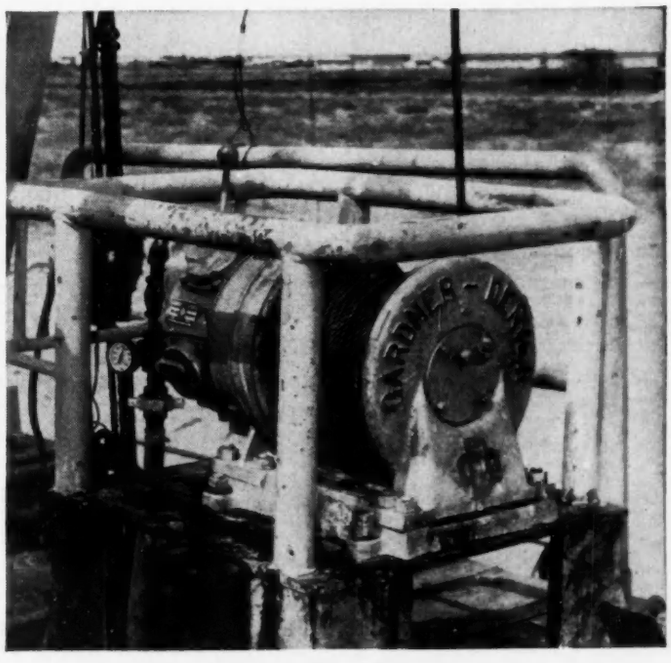

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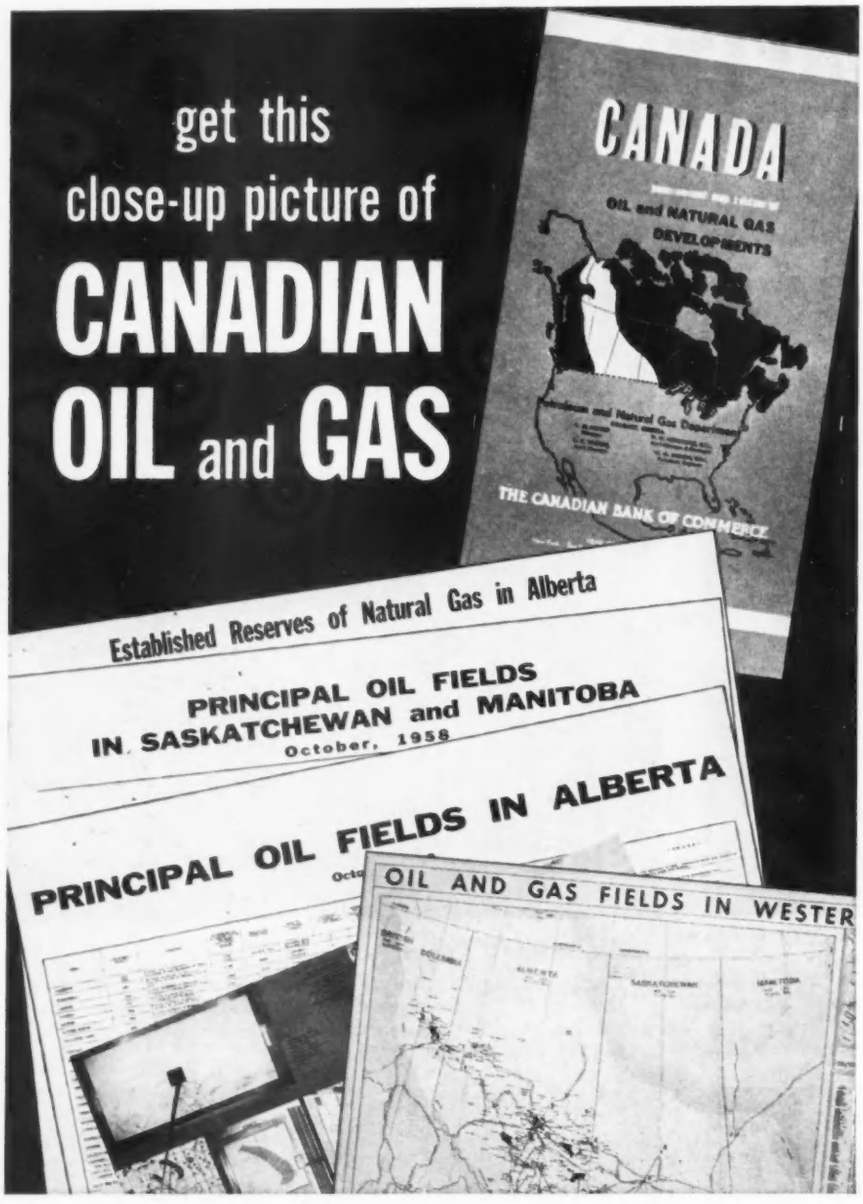

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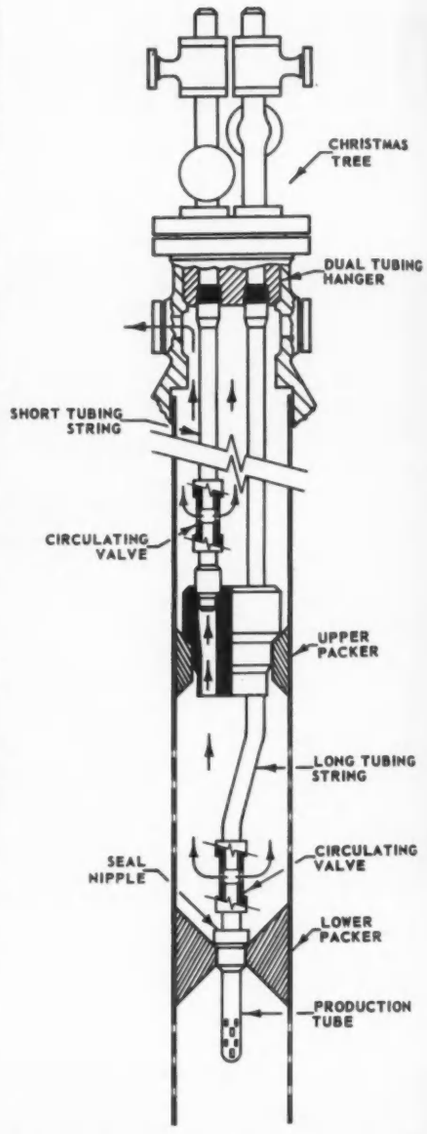

FIGURE 1—Circulating valves or sleeves can be used as shown in displacing multiple completed wells. Variations of this method include: (1) running a single circulating device between packers and circulating out through the short string, and (2) running two valves (one on each string) above the uppermost packer and circulating out through the annulus.

vices run on the tubing string allow displacement of mud within the tubing string with complete pressure control (Figure 1). Circulating valves can be used in several different ways. In a two-packer well, a circulating valve can be run between packers on the long string. After the short string is set and the tree installed, mud can be displaced by pumping down the long string, out the sleeve valve and up the short string. When displacement is completed, the valve is closed by wireline.

A variation of the above method is the use of two circulating devices, one positioned on the long tubing

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string between the packers and the other on the short tubing string above the upper packer. This arrangement permits displacement of the mud within the casing annulus with water or oil, which sometimes is desirable to help prevent corrosion of the casing or to facilitate tubing or packer removal at a later date.

Tubing string manipulation. In single completions which utilize a drillable packer, it is common practice to disengage the seal nipple from the packer by picking up the tubing and circulating after suitable surface control equipment has been installed. With multi-zone completions, this basic principle is practiced even though the procedure is more complicated.

During individual tubing string manipulation, the long string usually is displaced after it is run into the well, and prior to its suspension in the tubing head. If the production tube below the packer seal nipple is short enough, communication with the lower formation is prevented by a spring loaded flapper valve or some other type of back pressure valve in the lower packer. When the seal nipple and production tube are withdrawn to circulate, the valve automatically closes, isolating the lower zone from the casing annulus.

After displacing, the production tube and seal nipple are lowered, opening the valve. Pressure control at the surface is provided by a back pressure valve set in the tubing or hanger, or by the master valve of the tree, depending on the type of equipment used. Back pressure valves used allow fluid to be pumped down the tubing bore, but prevent back-flow. These valves can be removed through the tree under well pressure. After the long string is run, displaced and suspended, the identical procedure is followed with the short tubing string.

Again, pressure is controlled by attaching the tubing to the christmas tree or through use of a back-pressure valve. After the mud is displaced, the tubing string is lowered to position the seal nipple within the packer bore and the christmas tree is installed.

Simultaneous tubing string manipulation. Another method of displacement is gaining acceptance throughout the industry. After both tubing strings have been run and the tree installed, the lowermost flange of the wellhead body is unbolted. A lifting flange is attached to the top portion of the tree, and both tubing strings, together with the christmas tree, are picked up far enough to withdraw the seal nipples from the packers. A dual stuffing box type of tubing hanger seated in the bowl of the wellhead body provides a seal for both tubing strings and the casing annulus (Figure 2).

With both tubing seal nipples clear of the packers and the casing annulus sealed, water or oil can be pumped through the christmas tree into the tubing string, up the casing annulus and through the outlet of the wellhead body.

After displacement, the christmas tree and the attached tubing strings

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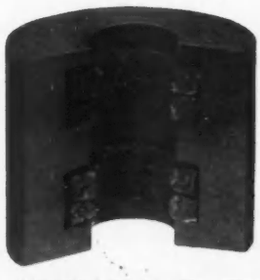

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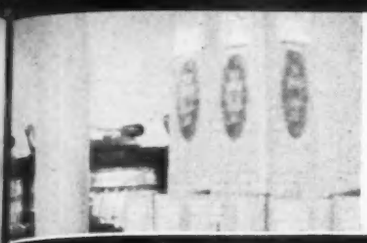

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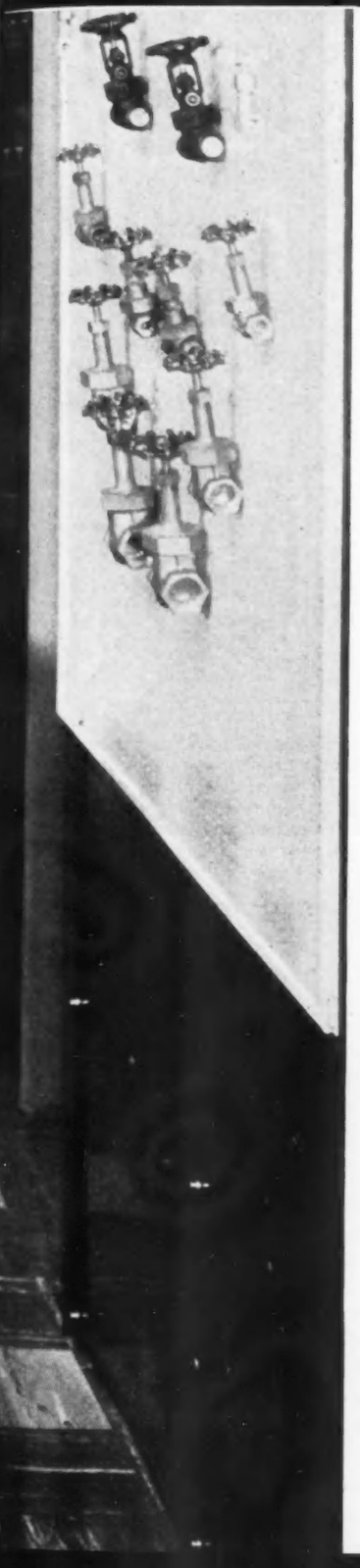

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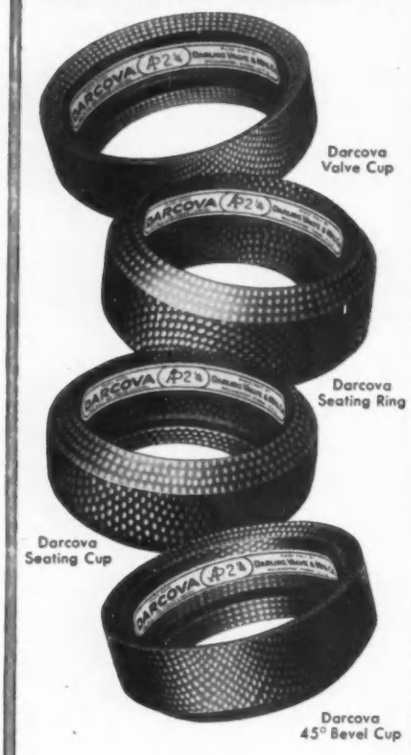

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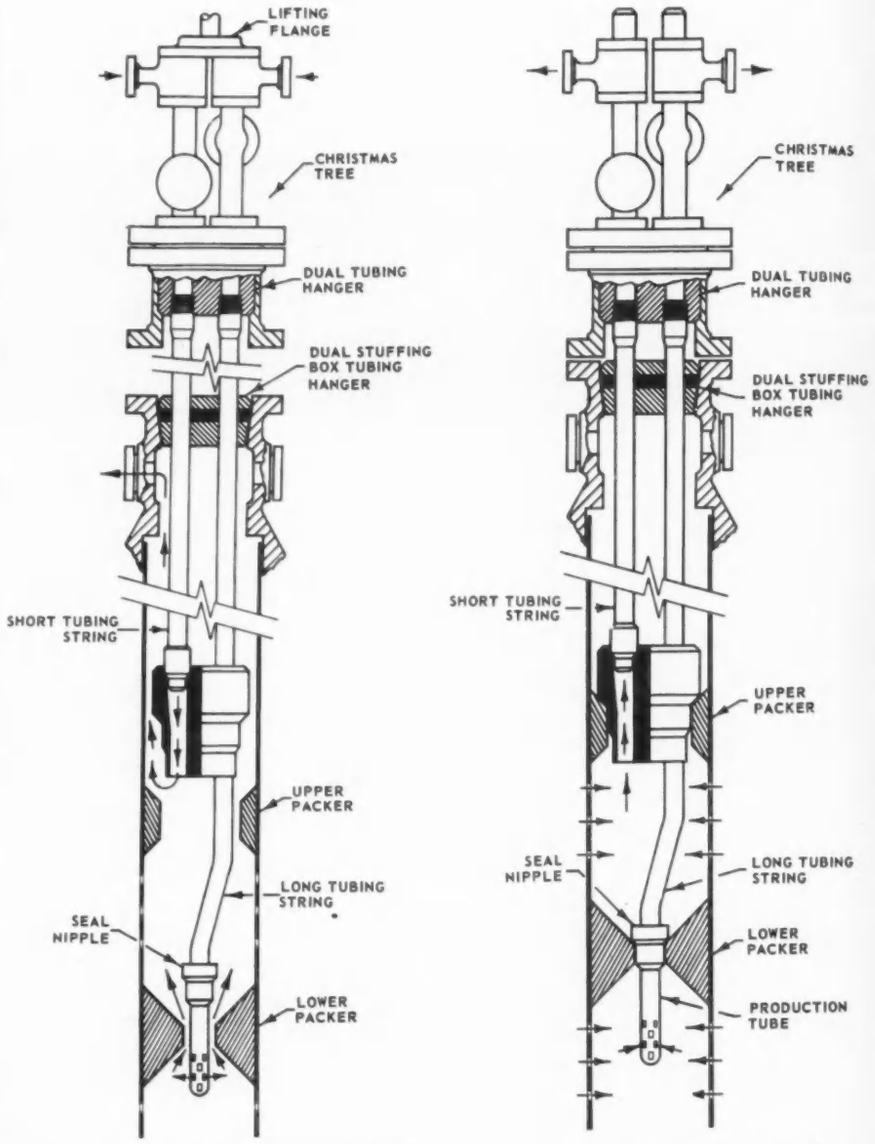

FIGURE 2—A dual stuffing box type tubing hanger permits simultaneous manipulations of both tubing strings. At left, both strings of tubing have been picked up at the same time and seal nipples are withdrawn from the packer bore permitting circulation around the pipe. Mud is displaced by pumping down each string of tubing and circulating out through the annulus. After displacing, the tree is lowered and flanged up in the same manner as a single completion (right).

are lowered until the tubing spool flange can be bolted into correct position (Figure 2). Simultaneously, the seal nipples engage the packer bores to effect a seal.

Hydraulic set packers. Another method of multiple displacement recently introduced utilizes hydraulic set packers. The chief difference between this method and others described previously is that it is not necessary to pick up the tubing strings in order to displace; packers are not set until the mud is circulated out of the tubing strings. Packers are set when required by hydraulic pressure from the surface.

There are several different methods for setting hydraulic packers. One is to pump a plug down the tubing until it seats in the packer. Application of additional pressure within the tubing creates a differential across the packer causing it to set. The plug then can be retrieved with a wireline. If a ball is used instead of a plug, it can be flowed from the well. One type of plug is pumped through the packer to bottom after the packer is set. If there is more than one packer, each can be set selectively.

These displacement methods are those most commonly used at present. Although procedures and illustrations deal with two strings of tubing, displacement methods outlined are equally applicable to wells with three

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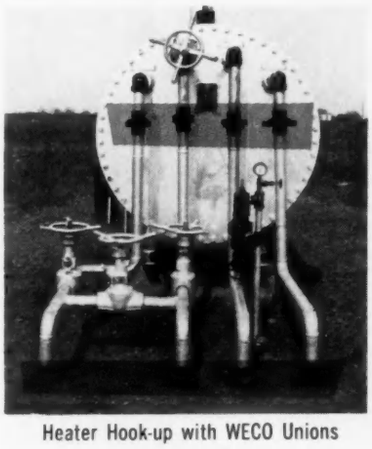

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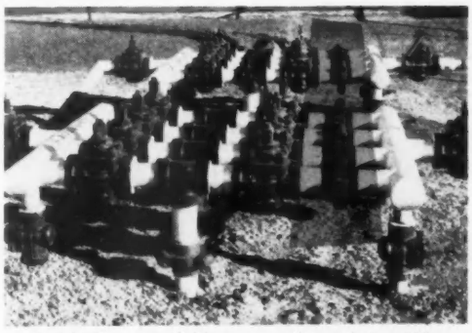

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About the Author

William W. Word, Jr. received a B.S. degree in aeronautical engineering from Texas A. and M. College in 1948. He was employed by The National Supply Company as an engineer upon graduation and has worked for them since. His primary duty with National Supply has been the design of wellhead equipment for the control of oil and gas wells. He has also been concerned with engineering aspects of manufacturing, inspection, testing and material control. He was appointed assistant chief engineer in November 1957.

or four tubing strings. Wellhead equipment for simultaneous manipulation of three tubing strings already has been developed; it would be relatively simple to design comparable equipment for four strings of tubing. Equipment used when displacing by swabbing or by circulating valves is the same regardless of the number of tubing strings in the well.

Quadruple tubing string wells on which information is available either have been swabbed in or have had the mud displaced by circulating after the installation of the christmas tree. This was achieved through use of hydraulic set packers.

This article is condensed from a paper entitled "Methods of Displacement in Multiple Tubing String Wells" which was presented to the American Society of Mechanical Engineers Petroleum—Mechanical Engineering Conference in Houston, Sept. 20-23, 1959.

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[2] "Multiple Parallel String Completions" by John R. Feeser, ASME Paper No. 57-PET-37 ASME Petroleum Mechanical Engineering Conference, Tulsa, Sept. 22-25, 1957.

[3] "The Selection of a Multiple Completion Hook-up" by W. S. Althouse, Jr. and H. H. Fisher, *Journal of Petroleum Technology*, Volume X, No. 12, Page 12, December, 1958.

[4] "Problems and Economics of Dual Completions" by F. G. Prutzman, Sun Oil Company, *The Petroleum Engineer*, Page B92, July, 1955.

[5] "Multiple Completions Save Money Offshore" by Jack H. Ray and Kermit G. Rowley, Magnolia Petroleum Company, Morgan City, La., WORLD OIL, June, 1958.

WHO'S MEETING WHERE

OCT.	
1- 3	National Association Petroleum Landmen, Southwestern Legal Center, Dallas.
2- 3	Desk and Derrick Clubs of North America, 8th Annual Convention, Hilton Hotel, San Antonio, Texas.
4- 7	Society of Petroleum Engineers of of AIME, 34th Annual Fall Meeting, Dallas.
5- 7	NACE, Northeast Region Conference, Lord Baltimore Hotel, Baltimore, Md.
8- 9	Second Annual West Coast Petroleum Land Institute, General Petroleum Corp. Auditorium, Los Angeles.
8-10	AAPG, 2nd Annual Meeting of the Southwestern Federation of Geological Societies, Lubbock, Texas.
8-10	Ninth Annual Drilling Symposium, Pennsylvania State University, University Park, Pa.
8-11	Third Biennial Louisiana Gulf Coast Oil Exposition, Blackham Coliseum, Lafayette, La.
11-13	AAODC, Nineteenth Annual Meeting, Oklahoma City.
12-14	Eighth Annual Clay Conference, Oklahoma University, Norman, Okla.
12-15	NACE, South Central Region Conference, Cosmopolitian Hotel, Denver.
15-17	New Mexico Geological Society, Tenth Annual Field Conference, Socorro, N. M.
19-23	Petroleum Landmen's Institute, University of Oklahoma, Extension Division, Norman, Okla.
20-22	NACE, North Central Region Conference, Cleveland, Ohio.
22-23	Society of Petroleum Engineers of AIME, Los Angeles Basin Section, Fall Meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
25-27	Independent Petroleum Association of America, Annual Meeting, Statler-Hilton Hotel, Dallas.
27-29	AIME-ASME, Joint Solid Fuels Conference, Netherland-Hilton Hotel, Cincinnati, Ohio.
28-30	AAPG, Mid-Continent regional Meeting, Broadview Hotel, Wichita, Kan.
29-30	Oil Recovery Symposium on Southwest Texas, Corpus Christi.
Nov.	
4- 6	Rocky Mountain Oil and Gas Association, 14th Annual Convention, Cosmopolitian Hotel, Denver
5- 6	AAPG, Pacific Section Regional Convention, Ambassador Hotel, Los Angeles.
9-11	API, 39th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotel, Chicago
9-12	SEG, International Meeting, Biltmore Hotel, Los Angeles.
10-11	API, Board of Directors Meeting Conrad Hilton Hotel, Chicago.
11	API, Executive Committee of Board of Directors, Conrad Hilton Hotel, Chicago.
11-13	Gulf Coast Association of Geological Societies, Executive Committee, Coliseum, Houston.
19	West Texas Oil X Gas Association, Twenty-sixth Annual Meeting, Hotel Windsor, Abilene, Texas.
Dec.	
3- 5	Interstate Oil Compact Commission, Sheraton Hotel, Philadelphia.
7	AIME, Arizona Section, Annual Meeting, Tucson, Ariz.
20	Oil Trades Association of New York Meeting, Waldorf-Astora Hotel, New York City.
Jan.	
11-13	First International Symposium on Arctic Geology, Jubilee Auditorium, Calgary, Alberta.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

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What's Happening

among MEN in the INDUSTRY

Dr. C. O. Tongberg

R. C. Curtis

Dr. Carl O. Tongberg has been elected executive vice president of **Esso Research and Engineering Co.** At the same time it was announced that **R. C. Curtis,** executive vice president of **Jersey Production Research,** has succeeded Tongberg as president.

The Bureau of Mines' station at Bartlesville, Okla., has had a change in operations and a change in name. The station changed its name from the Petroleum Experiment Station to the **Petroleum Research Center. Harry C. Fowler,** who has been superintendent, has been named the first research director. **K. J. Hughes** has been named superintendent. **D. B. Taliaferro** is head of the newly formed Division of Mineral Resources. The research work at the center will be under the active direction of six project coordinators. **C. C. Ward,** chemistry and refining; **J. P. McCullough,** thermodynamics; **C. K. Eilerts,** petroleum reservoir fluids; **H. N. Dunning,** surface chemistry and natural gas engineering; and **J. W. Watkins,** applied field engineering. The field engineering studies at Dallas and Wichita Falls, Texas, will continue under **K. F. Anderson** as project coordinator at Dallas.

H. J. Gruy and Associates, Inc., Dallas firm of consulting petroleum engineers and geologists, announces the addition to its staff of **Don L. Hall,** geologist. Hall graduated from The University of Texas with a B.S. degree in 1949. He has worked in the geological departments of Sinclair Oil and Gas Company, and Hill and Hill, Oil Operators.

Don L. Hall

James G. Dodd, consulting geologist, formerly with Tennessee Gas Transmission Company, has announced the opening of his offices in the Bank of The Southwest Building, Houston. Dodd will offer evaluation of producing properties, reserve estimates, report analysis, geological reports and drilling prospects reviewed.

Helmerich & Payne, Inc., Tulsa, has announced the acquisition by its Venezuelan subsidiary of **International Drilling Co., Inc., C.A.**

James Edwin Fox, Jr., has been named division drilling superintendent for **Pan American Petroleum Corporation.** Fox replaces the retired **James L. Nichols** and will make his headquarters in the Fort Worth offices of the company.

J. E. Fox, Jr.

Cosden Petroleum Corporation's Exploration Department has moved to Midland, Texas, from the Company's main office in Big Spring, Texas. **E. K. Dodson,** vice president in charge of exploration, heads the new Midland office. **Harry S. Lain,** chief geologist; **Warren A. Wilson,** chief geologist; and all exploration geologists in the area are now staffed in Midland.

Frank K. Levin has been appointed to the position of research associate in the Geophysical Division of **Jersey Production Research Company,** Tulsa based affiliate of **Standard Oil Company (N.J.).**

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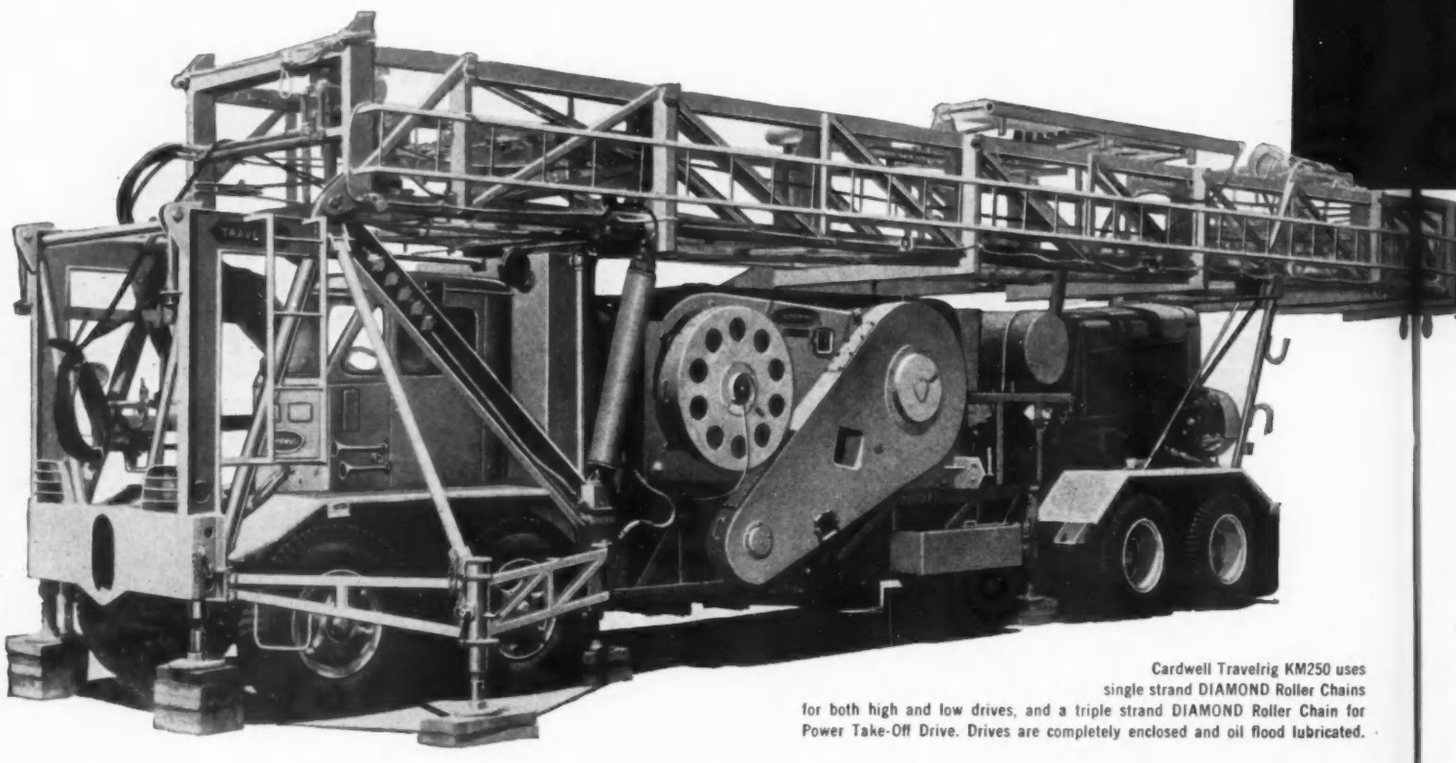

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Phillips Petroleum Company has established an oil and gas exploration office in Australia, and **J. J. Tanner** has been promoted to manager of the company's new Australian operations with headquarters in Brisbane. **C. D. Hier** has been advanced to chief geophysicist, and **H. H. Heikkila** to division geologist for the operations.

J. J. Tanner

Esso Research and Engineering Company, scientific and engineering affiliate of **Standard Oil Company (N.J.),** has announced that **Richard Paul Crowley** and **Hugh Edwin Ramsden** have joined the staff of that organization.

Don B. Winfrey, formerly chief geophysicist for City Service Petroleum, Inc., has joined **Petty Geophysical Engineering Company** as assistant to the president in charge of all geophysical operations.

Colorado Oil and Gas Corporation has recently formed a new regional division to supervise operations in the Mid-Continent and Rocky Mountain areas. **F. W. (Ted) Heiser** has been appointed manager of the office which is located in Denver.

William R. Gannaway has been appointed assistant division chief geologist for **Sun Oil Company's** Mid-Continent Production Division. He will continue to make his office in Tulsa.

Gulf Oil Corporation has named **Eugene Hosford** as operation coordinator for Domestic Production. Hosford transferred to Houston from Fort Worth where he has been division production coordinator. He succeeds **N. C. Simpson** who recently was elected an administrative vice president and coordinator.

James C. Conner has been named to a newly established position as administrative assistant to Chairman of the Board **Frank O. Prior** of **Standard Oil Company** (Indiana).

Texaco Inc., has recently named **Quincy V. Tuma** chief safety engineer for the nationwide activities of Texaco. Tuma succeeds the retired **Charles A. Miller,** and will make his office in the Houston offices of the company.

Quincy V. Tuma

Cities Service Oil Company has realigned its Production Division operations in Oklahoma. **D. S. Bodie,** district superintendent at Columbus, Texas, has been named division superintendent and transferred to Lindsay, Okla. **C. T. Kemerling,** Odessa, Texas, moves to Lindsay as district clerk and **George L. Goodman** of Columbus has transferred to Lindsay as production foreman. **J. W. Wise,** district superintendent in the Lindsay area, has established a new district production office in the Oklahoma National Bank Building at Chickasha.

The Secondary Recovery Engineering Company is a newly organized firm located in The American National Building, Oklahoma City, that offers the oil industry services for planning, designing, industrial water supplies and industrial waste disposal systems. **L. J. Hays, Jr.,** is executive vice president in charge of the company. Associated with Hays in the firm are **R. T. Pollard** and **A. L. Pollard,** secretary-treasurer of the company.

L. J. Hays, Jr.

H. L. Rowley has announced the formation of a new drilling company specializing in slim hole drilling operations. It is named the **Rowley Drilling Company** and will maintain offices in Natchez, Miss., and New Orleans. Rowley will serve as president. Other officers include **Stephen J. Rowley,** executive vice president; **Phillip G. Reynolds,** vice president and superintendent of drilling; **Carl B. Kendrick,** secretary-treasurer.

Ammon M. Wright has been promoted to assistant division manager of exploration for **Sunray Mid-Continent Oil Company.** Wright was until his promotion district landman for Western Oklahoma.

Sol Smith, consultant, petroleum and natural gas engineer, Austin, Texas, has been elected to the board of directors of **Seminole Oil and Gas Corporation,** in charge of technical operations.

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Dellson Drilling Company has announced that **Bert E. Sager** has returned from Illinois to Denver to join their firm as a vice president.

S. L. Kennedy, president of **Triad Drilling Company** has announced his purchase of all of the outstanding stock of Triad and has resigned as president of Cheyenne Oil Corporation. He plans to continue operating Triad and the present personnel will be retained.

John L. Hoyt, Jr.

John L. Hoyt, Jr., has been named division production superintendent for **Pan American Petroleum Corporation's** North Texas-New Mexico Division. Hoyt will make his office in Fort Worth where he replaces the retired **Earl V. Hewitt.** Hoyt was district superintendent in New Orleans before his present appointment.

Phillips Petroleum Company has announced a number of personnel changes affecting its Billings, Mont., Land and Geological Division office. **W. D. Tutten,** formerly assistant division development geologist at Denver, has been promoted to division development geologist at Billings, replacing **D. W. Buelow** who has transferred to Alaska as Anchorage division manager. **C. F. Darling** has been promoted from pool development geologist to assistant division development geologist, succeeding **F. M. Tunnell** who has moved to Bartlesville, Okla., in the company's geological engineering analysis section. **K. W. Calderwood** has been named Anchorage division geologist, replacing **S. P. O'Rourke** who also has transferred to Bartlesville.

Arthur J. Wessely

Arthur J. Wessely has been elected vice president and director of exploration of **Global Oils, Inc.** Wessley has served on the geological staff of the Sun Oil Co. in Dallas, and as senior geologist in the Engineering and Consulting Department of Core Laboratories, Inc.

Steve C. Maples has opened his office as a consulting geologist in the Commerce Building, Okmulgee, Okla. Previously, Maples was associated with Sohio Petroleum Company in Oklahoma City as senior geologist responsible for the geological aspects of development and evaluation of potential waterflood prospects.

Stekoll Petroleum Corporation has opened a field office in El Tigre, Venezuela. **O. B. Rylander** is the field superintendent, **T. W. Little,** production superintendent and **L. W. Myers** has been appointed technical manager.

J. R. Weyler has been promoted to assistant to division manager of **The Pure Oil Company's** Southwestern Producing Division, replacing **Charles W. Hancock** who has resigned to establish an independent consulting firm, **Charles W. Hancock and Associates, Inc.,** in Dallas.

The Vickers Petroleum Company, Inc., soon will open a new district production office in Perryton, Texas. The new office will be under the supervision of **Walter Kilgo.**

J. L. Latimer, president of **Magnolia Petroleum Company,** has become senior vice president of the **Mobil Oil Company** in a reorganization of operations of Magnolia and the other principal wholly owned affiliates of the **Socony Mobil Oil Company** in the United States. They will be combined with domestic operations of the parent company into a single coast-to-coast operating company, Mobil Oil Company. **Fred H. Moore** has been appointed vice president of Mobil Oil in charge of exploration and producing.

Burton M. Casad

Continental Oil Company has appointed **Burton M. Casad** as research engineer in the Company's Production Research Division. Casad was previously employed by Halliburton Oil Well Cementing Company and Phillips Petroleum Company, and taught at Oklahoma State University.

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BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc.....TE 5-7046, ZF 8-2023
CABIMAS, ZULIA, VENEZUELA
Wireline Engineers, S. A.
CASPER, WYOMING—C. A. White.....3-5264
CORPUS CHRISTI, TEXAS—Tolle, Inc...TE 5-5367
FARMINGTON, NEW MEXICO
B & R Service, Inc.....DA 5-2393
FORT MORGAN, COLORADO—C. A. White....919
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUMA, LOUISIANA—Cameo, Inc.....7330
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
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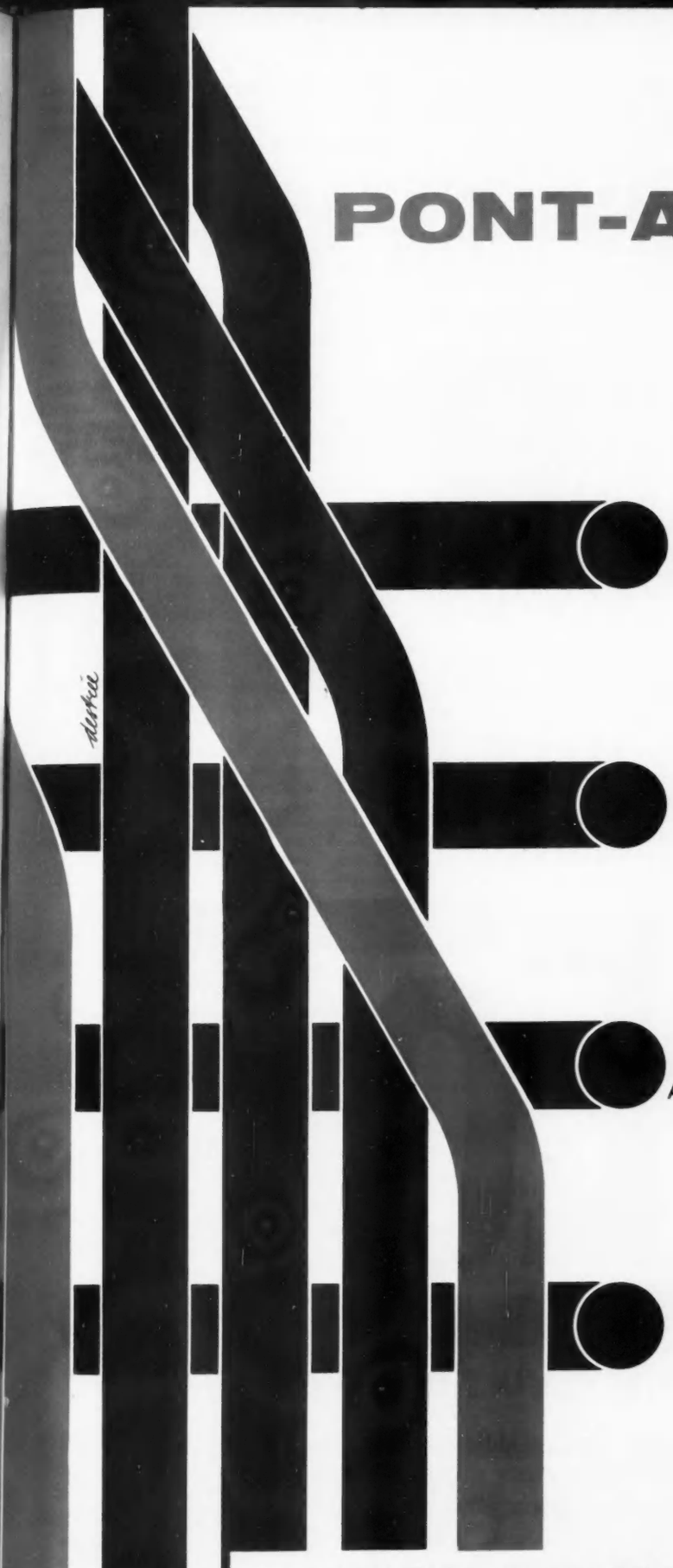
Mid-Western Well Ser. Co.....RE 4-4262
HOUSTON, TEXAS
Long Line Production Co.....GR 3-5739
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
Cameo, Inc.....CE 5-3124
LIBERAL, KANSAS—Rainbo Service...Main 4-3598
MIDLAND, TEXAS
Lucceus Service & Eqpt. Co.....MU 2-1631
HOUMA, LOUISIANA
Assoc. Eng. & Equip. Inc.....UP 2-0347
ODESSA, TEXAS
Cameo Wire Line Service, Inc.....FE 2-6497
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
PETTUS, TEXAS
Eddie Jones Eng. Co., Pettus 16, Beeville, FL 8-1218
SHREVEPORT, LOUISIANA—Cameo, Inc....8-3615
VICTORIA, TEXAS—Cameo, Inc.....HI 3-9521
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731
WICHITA FALLS, TEXAS—Hudson-Eads, Inc.
322-8584, 322-1792, 767-8727, 723-4690, 767-3793



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Donald B. Edwards has opened an office in Tulsa as a consultant on natural gas and natural gas liquids. Edwards will specialize in surveys, and in economic analysis and marketing and supply problems in natural gas, and in the economic analysis and development of gasoline and cycling plants. Edwards was previously employed as sales superintendent with Pan American Petroleum Corp.

Donald B. Edwards

Roland C. Shaw, vice president-Eastern Hemisphere, **Texfel Petroleum Corporation,** Dallas, has been elected president, director general, of Texfel's French subsidiary, **Transworld Petroleum, S.A.F.**

Peterson Exploration, Inc., Shreveport, La., has announced that **Clayton Glenn Price** has joined that firm in the Production Department as a petroleum engineer.

T. M. Dailey, Jr., executive assistant to the president, has been appointed manager, Planning and Personnel departments, **Tidewater Oil Company.**

Exploration Unlimited, Inc., has been organized in Tulsa and will engage in all types of radioactive surveys especially applied to petroleum exploration. Headquarters have been established in the Wright Building. Officers include **William D. Crews,** petroleum consultant, president; **Clarence E. Canady,** geophysicist, first vice president, and **John L. Dunn,** attorney, second vice president.

E. G. Catlett and **E. P. Burke, Jr.,** have announced the formation of **Pel-Tex Petroleum Company, Inc.,** to engage in all phases of oil operations. The offices for the newly formed company are located in the Esperson Building, Houston.

Charles W. Hancock and Associates, Inc., newly organized as an independent firm to engage in oil and gas property management, has opened offices in Dallas. The new firm will also advise and direct administrative functions, and provide specialized engineering and technical assistance to producing firms operating in the Gulf Coast, Mid-Continent and Rocky Mountain areas.

C. W. Hancock

J. H. Davis, Houston, has been promoted to assistant manager of **Continental Oil Company's** headquarters Geological Section. Davis formerly was exploration manager for the company's CATC marine region. He continues to make his headquarters in Houston and succeeds **G. H. Galny,** who was recently promoted to division geologist for Conoco at Durango, Colo.

Sun Oil Company's Southwest Division office recently moved into its new quarters in the new 42-story Southland Tower Building, Dallas.

Luis G. Morales, formerly chief geologist for Petroleo Brasileiro, has been named to head the oil and gas exploration activities of **Tennessee Gas Transmission** subsidiary firms in two South American countries, **Tennessee Argentina, S.A.,** and **Chaco Petroleum, S.A.** Morales has established headquarters in Buenos Aires, Argentina.

White Eagle Oil Company stockholders voted at a special stockholders' meeting recently to change the corporate name to **Helmerich & Payne, Inc.,** the name of a principal operating division of the Company in recent years.

J. M. Roberts has been named manager of **Shell Oil Company's** Houston area Land Department. Other personnel changes in the Company's New Orleans exploration and production area management include **E. J. McLain** named assistant to the vice president; **E. C. Abell,** former area land agent succeeds McLain as manager of the Land Department; **Frederick J. Toth** was named area production superintendent.

The Vickers Petroleum Co., Inc., in an initial phase of a decentralization program, has moved its Wichita, Kan., exploration and production and research departments, along with the offices of **J. A. Vickers,** president, to new quarters in the Tower Building, Denver.

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Occidental Petroleum Corp., has merged with **Gene Reid Drilling, Inc. E. C. (Gene) Reid** was elected to the board of directors of Occidental and will serve as vice president in charge of all oil and gas production and development in the parent company.

E. C. (Gene) Reid

•

Petroleum Information, Denver, has announced that **B. H. (Bill) Brandon** has joined that firm as manager of Well Record Service. Brandon was formerly chief of the Data Control Center and Scouting Department for Richfield Oil Corp., in Los Angeles.

•

Continental Oil Company has established a Montana production district with Lewistown as headquarters and **Robert E. Larsen,** formerly of Cody, Wyo., as district superintendent. **Kent W. McDaniel,** district engineer, and **Harold L. Brus,** district administrative coordinator, will also be headquartered in Lewistown.

•

Texas American Oil Corporation has announced the election of **Howard W. McCullough** of Chicago, senior vice president of Brunswick-Balke-Collender Company, to the board of directors of that oil firm.

•

Shell Oil Company has named **T. W. Dwyer** chief mechanical engineer for Shell's Pacific Coast area exploration and production. Dwyer replaces **J. E. Orrell** who has transferred to a similar assignment in the company's Midland, Texas, office.

T. W. Dwyer

•

Henry March, partner in Ladenburg, Thalman & Co., New York City, and a director of Champlin Oil & Refining Co., has been elected to the board of directors of **Producing Properties, Inc.,** following the resignation of **H. V. Sherrill,** of Shields & Co., New York City.

•

Cheyenne Oil Corporation has moved its principal offices from Wichita Falls, Texas, to Dallas. The new office is located on North Ervay.

•

Paul L. Kartzke, of Calgary, vice president in charge of **Shell Oil Company of Canada's** Exploration and Production activities in Canada, has announced the move of the Company's Edmonton offices from the Financial Building to its new offices in the Milner Building.

•

Chase Ritts, Jr., vice president and manager of the Houston division office of **Pan American Petroleum Corp.,** has been named to the advisory committee of Bank of the Southwest's board of directors.

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Kenneth Newton of **Plymouth Oil Company** has been promoted to regional supervisor at New Orleans, and is being transferred from regional geologist at Midland, Texas.

Pan American Petroleum Corporation has announced the appointment of **A. J. Inderrieden** as district engineer of the Lubbock, Texas, district. He replaces **Gus Athanas** who has been transferred to Canada.

J. A. Ransford has been named Washington, D.C., representative for **Tidewater Oil Company.** Ransford succeeds the retiring **L. W. Parsons.**

Shell Oil Company has announced the appointment of **J. F. Hunt** as the Houston area reservoir engineer. Hunt held the same position for the company in New Orleans.

Roger M. Matson, formerly vice president of Alex M. McCoy Associates, Tulsa, has become an affiliate with the **Vickers Petroleum Co., Inc.,** as a consultant geologist.

Kerr-McGee Oil Industries has named **Robert W. King** as district geologist for the Southern Rocky Mountain region, headquartering at Denver.

W. J. Lang, Tulsa, has resigned as geologist and exploration manager for Edward C. Lawson and Lawson Petroleum Co., to become a geologist-geophysicist consultant with offices in the Philtower Building.

Robert P. Evans

Robert P. Evans, vice president and director of Kin-Ark Oil Company, has resigned to operate as a consulting geologist in Shreveport, La. He will specialize in the Ark-La-Tex and Mississippi areas. Temporary offices have been established in Shreveport.

Dr. J. A. Reid has become director of research for **Phillips Petroleum Company** succeeding **W. B. Reynolds** who resigned.

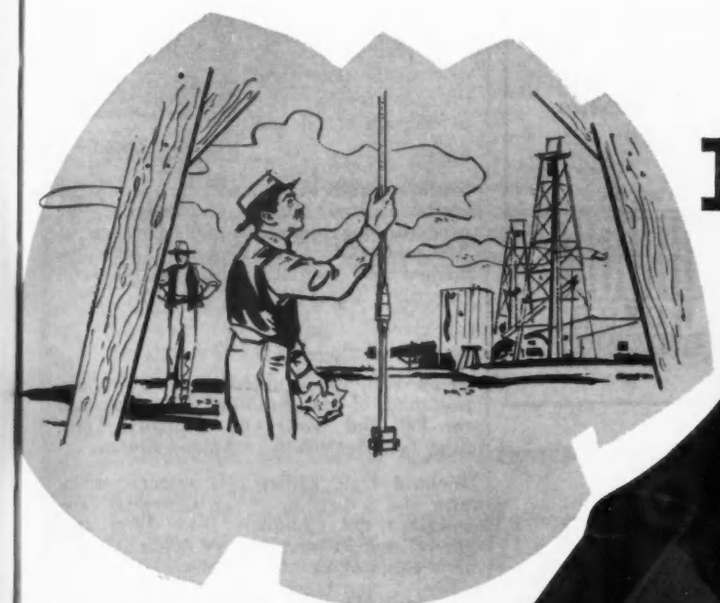
Delhi-Taylor Oil Corp. has announced four promotions in its Special Projects and Planning Division. **Dr. Elton Soltes,** manager of Special Projects, has been given over-all responsibility for the Division. **G. R. Gamble,** formerly supervisor of the Treasurer's staff, has been transferred to the Division as director of the new Planning Department. **B. J. Beard** has been promoted from gas engineer to director of the Natural Gas and Pipe Line Department. **Frank M. Coker** has assumed the duties of engineering advisor for the Special Projects and Planning Division.

Mayo Curtis, Tidewater Oil Company reservoir engineer for the firm's western division, has been named to the Flying A company's Production Research Group which is headquartered in Houston.

Joe T. Dickerson, Houston, who retires January 1 as president of Shell Pipe Line Corp., will head the **Mid-Continent Oil and Gas Association's** proposed industry information center in Washington, D.C. The announcement was made in Houston

JONES

FIRST IN 1894...



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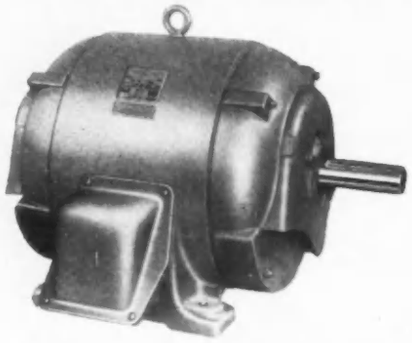

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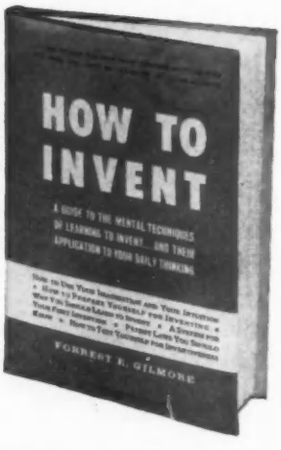

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by Association President **William J. Goldston.** Dickerson also will become executive vice president of the association.

Ron McKenzie has been appointed vice president, Technical Services, of **Transworld Management Corporation.** McKenzie was formerly with Lester Oberholtz Associates of Los Angeles.

Shell Oil Company has announced that **J. E. Wilson,** acting Houston area exploration manager, has been nominated to succeed **E. D. Cumming,** vice president of Shell's Houston area who retires at the end of the year.

Lee Flood

Lee Flood of Houston has assumed the duties as manager of the **Fred Whitaker** interests, of Carthage, Texas. Previously, Flood was engaged in consulting work and in the development and introduction of new techniques and instruments in the production of oil and gas.

Shelton Goodwin, Jr., will be the district landman, and **Curtis J. Little,** district geologist for the **Lion Oil Division of Monsanto Chemical Company** who has opened new district exploration offices in Amarillo, Texas.

– Deaths –

Jacob Fell, independent oil operator and president of the **Bradford Company** and the **Fell and Wolfe Oil Company,** Tulsa, died July 5 after an extended illness.

Richard Dale Miller, 91, secretary-treasurer and a director of the **Universal Consolidated Oil Company** from 1936 until his retirement last January 1, died July 7 in a hospital in Los Angeles.

Alexander Deussen, Houston geologist and former geologist for **Gulf Oil Corporation,** died September 5.

James A. Doctor, executive vice president, marketing, **Vickers Petroleum Co.,** died August 19 from injuries received in an automobile accident near Augusta, Kan.

David S. McNeill, 92, retired Eureka, Kan., independent oil producer, died August 27 in Tulsa following a brief illness.

Albert S. Johnson, 76, pioneer California oil driller, died August 8 in his home in Long Beach, Calif., after a lengthy illness. **George B. Cree,** president of **Cree Oil, Inc.,** died August 14 in Pampa, Texas, after a long illness.

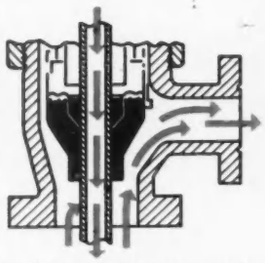
Richard Pratt, 65, financier and former **Standard Oil Co.** executive, died August 16 in Glen Cove, N. Y.

John R. Leonard, 44, Deer River, Minn., retired southwest regional geologist for **Phillips Petroleum Co.,** died in a Minneapolis hospital August 11.

Stanley A. Brander, 56, Tulsa, president of of **The Pioneer Corp.,** died August 4 in a Los Angeles hospital after a brief illness.

Fred P. Schweers, 53, Tulsa consulting geologist, died September 4. Before becoming a consultant he had been a geologist for the **Mercury Drilling Company.**

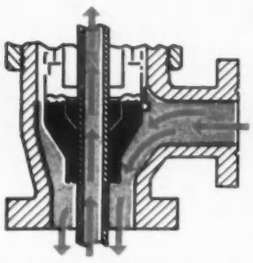
DRILLING WITH AIR OR GAS?



There is a steadily growing use of air or natural gas to replace the mud column in many drilling operations. Advantages include faster drilling rates, more footage per bit, no "lost circulation" problems, and greater production recovery.

The ideal unit for sealing off around the drill string and maintaining safe pressure control is the Shaffer Combination Rotating Blowout Preventer and Stripper. It not only permits the well to be drilled safely, but also it can be adapted to be used as a casing stripper during casing operations to maintain pressure control.

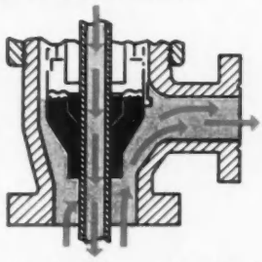
USING REVERSE CIRCULATION?



Reverse circulation is another of the modern drilling techniques that have definite advantages in certain types of formations. By returning the cuttings through the inside of the drill string, higher return velocities are obtained at lower pump pressures (and lower pressures on the formations). The higher velocities insure larger cuttings being returned from the formations, in many cases eliminating need for coring and thus saving rig time. Also by carrying large cuttings away faster, bit life is lengthened and drilling time is reduced.

These and other advantages make Reverse Circulation techniques worth investigating — and here again, the key to proper operation is a Shaffer Combination Rotating Blowout Preventer and Stripper to seal off the drill string and to control circulation pressure while drilling.

NORMAL DRILLING OPERATIONS?



Here again, this Preventer and Stripper insures safety and efficiency to a degree unmatched by any other type of hook-up. The unit seals off around the varying diameters of the drill string — pipe, couplings, tool joints and drill collars — adjusting itself **automatically** to the various diameters and shapes. It even seals safely around such shapes as square, hexagon or octagon kellys. And the seal is automatically maintained as long as the drill string is in the hole. No valves to operate, no levers to move — nothing to remember or forget when pressure emergencies threaten.

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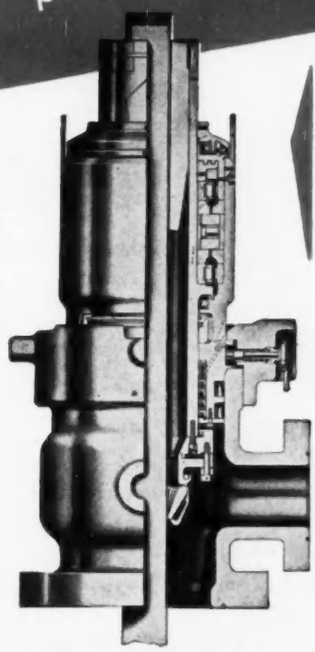

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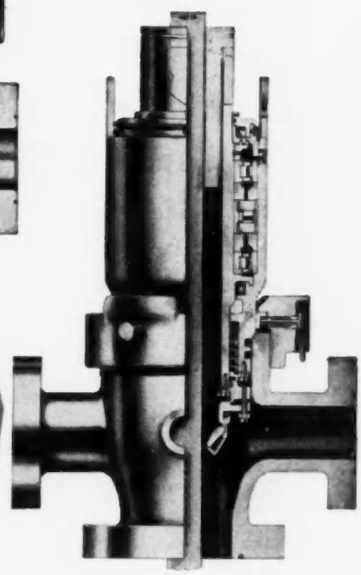
for all kinds of drilling operations, including drilling through 10¾" casing and larger.



USE THE TYPE 51

for blowout protection in slim hole drilling, drilling-in, production jobs, reworking of wells and similar applications.

Shaffer Combination Rotating Blowout Preventers and Strippers are known throughout the industry for the unequalled *automatic* protection they provide against pressure emergencies. Nothing to remember—or forget—when pressure emergencies threaten, because this equipment automatically seals off around the drill string as the tools are lowered into the well . . . *and maintains this pressure-tight seal—without attention—throughout all subsequent drilling operations.*

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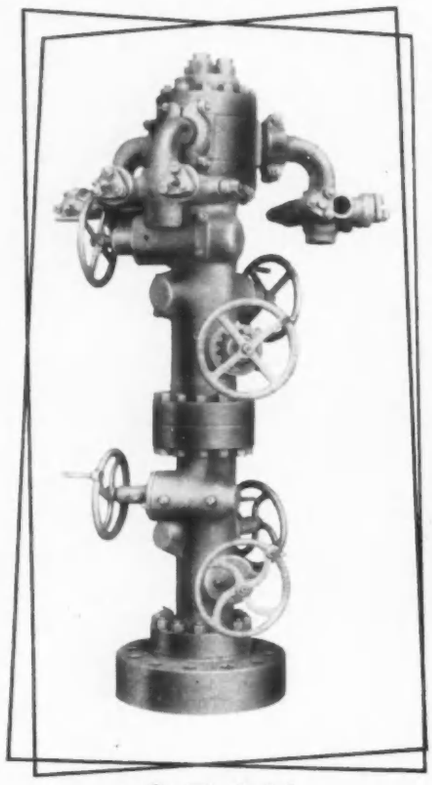

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Simplified design of Gray Well Control Systems offer maximum flexibility to provide for positive, efficient handling of every well control problem. Parts, creatively engineered to reduce areas subject to pressure, provide *more strength with less weight . . . complete control with complete safety*. Whatever pay zone you're working — deep or shallow, single or multiple zone — you can rely on a Gray Well Control System to give you practical, economical well control safety.

For more information about Gray's Systems of Well Control, see the Gray Catalog in Composite Catalog or write Gray Tool Company.

Safety is Economy

GRAY *Tool Company*

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641 5904

what's Happening

among INDUSTRY ASSOCIATIONS

New Members of Los Angeles NOMADS

Between Ritual Master Taylor Bannerman of Technical Oil Tool Corporation (left), and Lee Laird of Ladish Pacific Division, his assistant (right) are three new members inducted into the Los Angeles NOMADS at the September meeting. They are (left to right) Lloyd H. Hill of The National Supply Company, associate; James W. Merrill of WORLD OIL and Gulf Publishing Company, associate; and Walter Losk of Monarch Engineering Corporation, regular.

Texas Mid-Continent Elects Estill S. Heyser New President

Estill S. Heyser, Jr., Dallas independent oil producer and attorney, was elected president of the Texas Mid-Continent Oil & Gas Association at its fortieth annual meeting in Houston. Heyser succeeds Charles W. Alcorn, Houston independent producer and drilling contractor.

E. S. Heyser, Jr.

As a vice president for the past two years of the general Mid-Continent Oil & Gas Association, Heyser has been one of the planners in the recently announced reorganization of the large regional association for more effective Washington representation of the industry.

Also at the association meeting, Charles H. Lyons, Shreveport, La., independent oil producer who has been a leading spokesman in Washington for Southwest oil producers, and J. Harold Dunn, Amarillo, Texas, president of Shamrock Oil and Gas Corporation, were named as the 1959 recipients of the Texas Mid-Continent Oil & Gas Association's Distinguished Service Awards. The awards are presented each year to an outstanding independent oil and gas producer and a company executive.

Four new district vice presidents to head up area activities of the organization also were elected. All other district vice presidents and executives were re-elected and 25 new directors were named.

Newly-elected district vice-presidents are Marvin L. McCullough, Wichita Falls, North Texas; H. E. Dishman, Beaumont, Upper Gulf Coast; Alvin C. Hope, San Antonio, Southwest Texas; and C. E. Yager, Fort Worth, North Central Texas.

J. H. Dunn

C. H. Lyons

Named to new terms were Andrew M. Howsley, Albany, senior vice-president and general counsel; Charles E. Simons, Dallas, executive vice-president; and Eugene McElvaney, Dallas, treasurer.

Re-elected district vice-presidents were J. Clyde Tomlinson, Longview, East Texas; Joseph I. O'Neill, Jr., Midland, Permian Basin; Radcliffe Killam, Laredo, Lower Gulf Coast; E. J. Dunigan, Jr., Pampa, Panhandle; John W. Mecom, Houston, Middle Gulf Coast; and P. W. Pitzer, Jr., Breckenridge, West Central Texas.

New board members included E. R. Barry, Dallas; R. W. Blalock, Marshall; Roland S. Bond, Dallas; C. W. Brown, McCamey; John W. Crutchfield, Corpus Christi; Phillip Dana, Borger; Vernon Davis, Coleman; Cyrus B. Frost, Jr., Eastland; Harlan A. Hodges, Lubbock; F. Kirk Johnson, Fort Worth; Ralph A. Johnston, Houston; B. F. Jones, San Angelo; Jack S. Josey, Houston; Robert E. Kepke, Dallas; and N. E. Loomis, Longview.

D. A. McGee, Oklahoma City; Johnny Mitchell, Houston; Mrs. Pat O'Donnell,

Accident occurs . . .

Immediate first aid given . . .

TEIA authorizes hospital and medical treatment . . .

TEIA begins payment of weekly benefits.

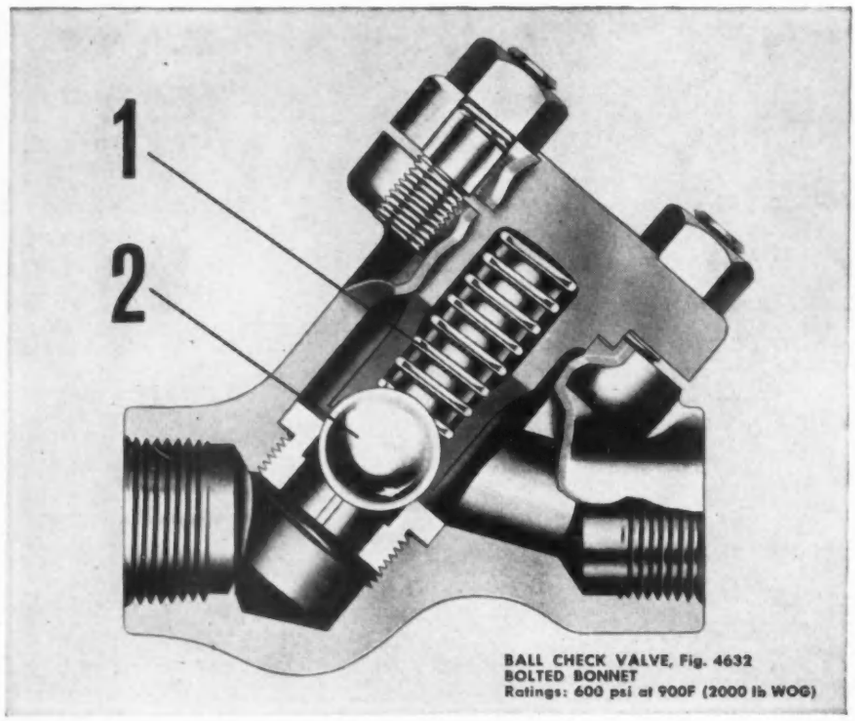
If you've bought your workmen's compensation insurance from TEIA, all of this is done promptly, efficiently. We believe that excellent claim service is a strong link in the chain of loyalty that links employer to employee. Most employers do, too; that's one of the reasons why employers in Texas buy more workmen's compensation insurance from TEIA than any other company. Why not see your nearest TEIA man soon?

First with Texas Industry for 45 years

PROMPT

TEIA TEXAS EMPLOYERS' INSURANCE ASSOCIATION

HOME OFFICE: DALLAS | 25 SERVICE OFFICES IN TEXAS | AUSTIN F. ALLEN, CHAIRMAN OF THE BOARD | BEN H. MITCHELL, PRESIDENT



BALL CHECK VALVE, Fig. 4632
BOLTED BONNET
Ratings: 600 psi at 900F (2000 lb WOG)

You get longer valve life with . . .

Edward Check Valves for petroleum services

For the many petroleum services from oilfield to refinery where protection against flow reversal is required, Edward furnishes a complete line of forged steel check valves for horizontal or vertical installation.

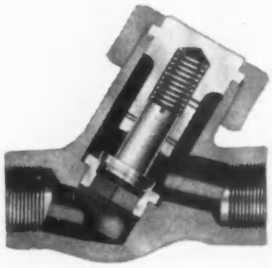
EDWARD BALL CHECK VALVES are specially designed to provide rugged, shock-free service where liquid or heavy viscous fluids are piped. The stainless steel spring (1 above) is sized and rated to give positive seating with heaviest of fluids. And the ball disk (2), made of EValloy 16% chromium stainless steel for tight seating, can be easily replaced when needed.

EDWARD PISTON CHECK VALVES also give freedom from shock or vibration, plus streamlined body design for full flow area and low pressure drop. Exclusive disk guide and spring loading allow for quick, positive seating.

LONG-LIFE FEATURES—Here are just a few design characteristics that make Edward check valves your best buy for petroleum services:

- **your choice of screwed, socket welding or flanged ends**
- **rugged bodies of specially heat treated forged steel**
- **strong spring of stainless steel for sure closing action**
- **corrosion-proof stainless steel seats, and stainless steel piston disks or ball disks**
- **union, screwed, or bolted bonnet available**

Edward builds a complete line of cast and forged steel valves for pressures to 10,000 lbs, with flanged, screwed, socket or butt welding ends. For additional information, see your favorite distributor, or write Edward Valves, Inc., 1214 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company.



PISTON CHECK VALVE, Fig. 3578
UNION BONNET
Ratings: 1500 psi at 850F (3600 lb WOG)

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Ranger; John J. O'Keefe, Houston; Frank Pool, San Angelo; Alton T. Remington, Fort Worth; C. R. Starnes, Jr., Gladewater; J. D. Tompkins, Abilene; Ben F. Vaughan, Jr., Corpus Christi; George Wilson, Dallas.

Dr. J. L. Gillson Elected President of AIME

Dr. Joseph L. Gillson, chief geologist of E. I. du Pont de Nemours & Co., has been elected president for 1960, of the 35,000-member American Institute of Mining, Metallurgical and Petroleum Engineers. Dr. Gillson and other officers elected with him will take office during the annual meeting of the institute, to be held in New York City Feb. 14-18, 1960.

Howard C. Pyle, Los Angeles, president, director and chairman of the executive committee of Monterey Oil Co., is currently president of the institute (AIME). He will serve until Dr. Gillson takes office in February.

AIME has named, as president-elect, to become president in 1961, succeeding Dr. Gillson, a distinguished Canadian, Ronald E. McNaughton, of Trail British Columbia, manager of the Metallurgical Division of the Consolidated Mining & Smeltering Co. of Canada, Ltd. He is a former director of AIME.

K. H. Shaffer Named To Oil Information Committee

K. H. Shaffer, Houston oil executive, has been named state chairman of the Oil Information Committee of the Texas Mid-Continent Oil & Gas Association. Formerly state vice chairman of the OIC, Shaffer, who is president of Standard Oil Company of Texas, succeeds G. T. Pearson, Continental Oil Company, Fort Worth, who now heads Conoco's Canadian operations.

K. H. Shaffer

As chairman of the Texas OIC, Shaffer directs a statewide oil information program that functions through some 1,400 volunteer oil men and women who make up 340 local committees in Texas.

The Texas Mid-Continent Oil & Gas Association, and the OIC recently moved to new offices located at 2920 Southland Center, Dallas 1, Texas.

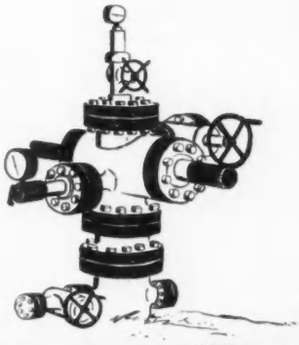
J. P. Hammond Named Vice President of AIME

John P. Hammond, assistant general superintendent of Amerada Petroleum Corp's Production Department, has been elected a vice president of the American Institute of Mining, Metallurgical and Petroleum Engineers.

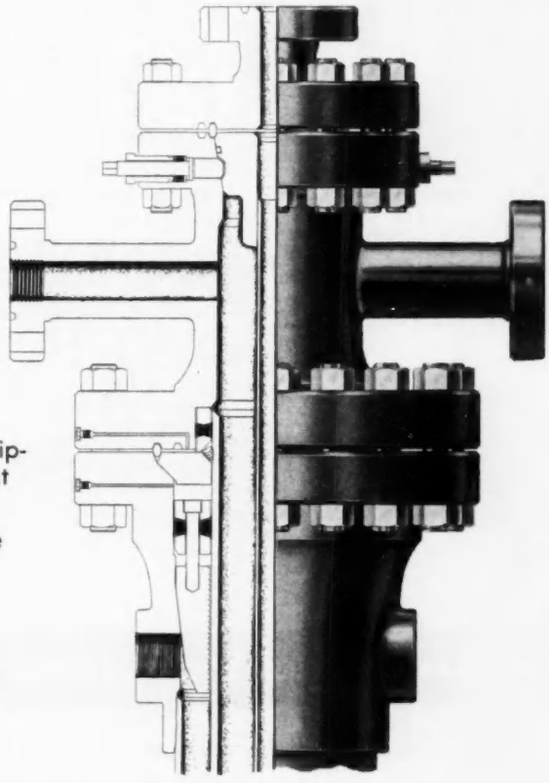
Hammond and other officers will assume their duties during the AIME annual convention in New York City Feb. 14-18, 1960.

Dr. Joseph L. Gillson, chief geologist of E. I. du Pont de Nemours and Co., Wilmington, Del., elected last year, will be the new president. Ronald E. McNaughton, manager of metallurgical division of Consolidated Mining and Smeltering Co. of Canada, Ltd., Trail, B.C., has been named president-elect for 1961.

Hammond is a former president of the Society of Petroleum Engineers of AIME and a national director of AIME.



FOR STORAGE WELLS TOO!



RECTOR SEAL-WITH-STEEL INSURES SAFETY—PREVENTS LOSS

The underground storage of liquefied petroleum gases is becoming increasingly important in solving the problems of seasonal storage of butane and propane gases.

Of vital importance to underground storage is the surface equipment necessary to insure safety of operation, and to prevent loss through leakage after storage wells are completed.

Rector "RH" casing heads and Rector "ML" tubing heads are ideally suited for storage well completions, and for oil and gas wells. The Rector seal-with-steel feature gives positive metal to metal seal, the trademark of Rector's design and safety. Rector *engineering know-how* is available to solve individual problems presented by varied underground storage installations. Rector equipment meets all standards of the API and the Association of Well Head Equipment Manufacturers. Tested to 22,500 lbs. as stipulated in API test specifications.

Use "Rectorseal" to insure leakproof threaded joints and connections, and Rector cementing equipment for better cementing jobs.

Be safe . . . be sure . . . buy Rector quality! See your Rector representative or your favorite supply store now!

PESA — PARTNERS IN PETROLEUM PROGRESS

MONOGRAMMED EQUIPMENT — CERTIFICATE NO. 2158

EXPORT REPRESENTATIVES

Continental-Emsco Co.

Mid-Continent Supply Co.

Oil Well Supply Division of United States Steel Corp.

Rector

WELL EQUIPMENT CO., INC.

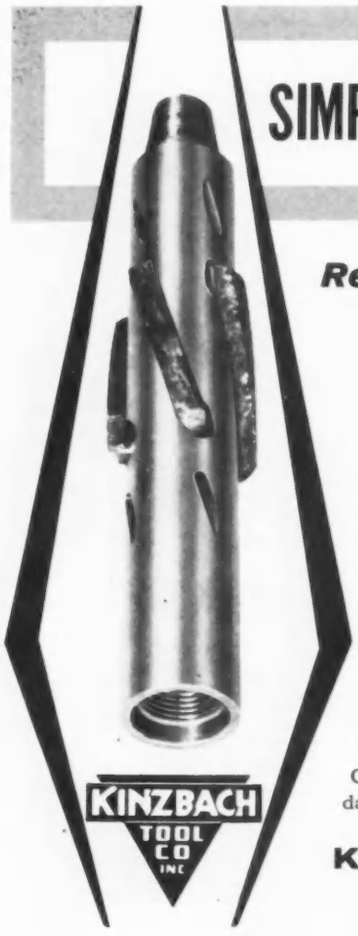
Making the Oil Industry Safer!

1100 North Commerce — Fort Worth, Texas

Houston Plant: 2215 Commerce Street

For more data on advertised products, use Readers' Service Cards, last page.

SIMPLIFY WITH KINZBACH!



Replaceable Blades Convert
STRING TOOL *to*
Guide • Reamer or Mill
• Stabilizer

This versatile tool is designed to use three different types of blades: as a string guide (Model 166) it uses soft steel blades; as a stabilizer (Model 167) it uses hard surfaced blades; as a reamer or mill (Model 168) it uses tungsten carbide faced blades.

The helically arranged blades, securely held in closed end receiving slots by elastic steel pins, cannot be lost in the hole. And changing blades on the derrick floor requires only a suitable punch and hammer.

Complete details available by writing for catalog data.

Patent Pending

KINZBACH TOOL CO., INC.

P. O. Box 277, Houston, Texas
Export Office: 74 Trinity Place, New York, N. Y.

Complete Portable Camps–

- Quality built for comfort!
- Quality built to last!

Whatever, wherever your housing need, call FA 3-9365, or write:

HOUSTON Ready-Cut House Co.

P. O. Box 124 Houston 1, Texas

John Pearce

T. M. Lumly, Jr.

Pearce, Lumly Named Officers By NOMADS Board of Regents

The National Board of Regents of NOMADS has named John Pearce as its chairman, and Thos. M. Lumly, Jr., as secretary-treasurer. Both are regents of the Tulsa Chapter.

Geologists Complete Plans For Mid-Continent Regional Meet

The American Association of Petroleum Geologists, in cooperation with the Mid-Continent Council of Geological Societies, will hold its regular biennial meeting in Wichita, Kan., on October 28-30, with the Kansas Geological Society and the Liberal Geological Society as co-hosts.

The Broadview Hotel will be the headquarters for the meeting and the site of activity. The theme of the convention will be "New Frontiers." The Mid-Continent discussion will range from Southern Oklahoma to Nebraska, and from Eastern Colorado to Arkansas.

NOMADS Elect Kircher

Don E. Kircher (right), export manager for Gardner-Denver Company, is shown accepting the gavel as president of the New York NOMADS from outgoing president E. E. Andreason. Kircher has lived in South America, the Middle East and Near East and has traveled in nearly every country of the world except Russia.

New Officers Elected by Dallas Geological Society

New officers for 1960 have been announced by the Dallas Geological Society. The newly elected officers are: President John C. Dunlap, DeGolyer and MacNaughton; First Vice President Paul W. Foster, Atlantic Refining Company; Second Vice President Jeff E. Miller, Jr., exploration consultant; Secretary Ross H. Ley, Sun Oil Company; Treasurer Edward L. Hazlewood, C. L. Norsworthy, Jr.; Past President Norman C. Smith, photogeological consultant.

***No rotation is necessary* with this tool during drill stem testing operations.**

You can take as many bottom hole shut-in pressures as you want without returning the testing valve assembly to surface.

You can also squeeze cement, re-perforate, fracture or acidize without ever pulling the tubing or drill pipe.

Then, if you need later tests, you can pump the pressure test section in place without ever making a round trip.

You can do all these things with full assurance that you are using a positive tool that is completely safe in operation. There is no guesswork. All operations involve simple up-and-down movement or a minimum of right hand rotation. No damage results from excessive rotation. No left hand rotation is ever required.

After all operations are completed, a built-in jar assures packer unseating when unseating is desired.

In addition, this tool is backed by Johnston Testers—the largest operator in the field of drill stem testing. You get all the advantages of Johnston's unparalleled experience when you specify the *Johnston* Test and Completion Tool. Fill out the coupon or drop us a note on your letterhead for full information. Please refer to bulletin number A6.3.

Please send me complete information on the New Johnston Full-Bore Test and Completion Tool.

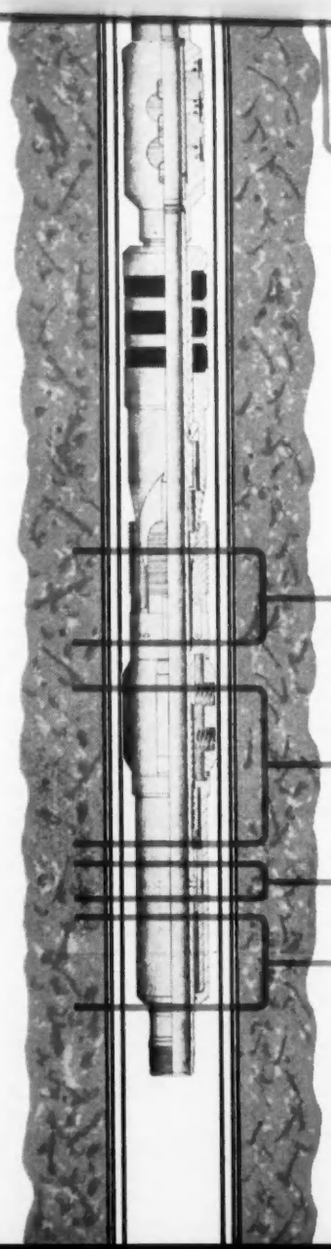
NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

A6.3



JOHNSTON TYPE "T" PRESSURE RECORDER gives unfailing accuracy, sensitivity and dependability under all testing conditions. This recorder is built to withstand unavoidable oil field jolts and is not apt to be knocked out of calibration. Non-tension type recorders may.

TWO-WAY ANCHOR SLIPS enable the operator to take a strain on the tubing without unseating the packer.

BUILT-IN JAR makes it easy to unseat packer. As in all other operations, no left hand rotation is required to operate or reset.

SIMPLE SETTING OF PACKER. Just pick up, torque to the right and slack-off, and the packer is set. The by-pass valve, which is closed when the packer is set, has a simple and positive opening and closing action.

FULL OPENING THROUGH TOOL (when testing valve assembly is out) permits perforating, squeezing, and other operations without difficulty.

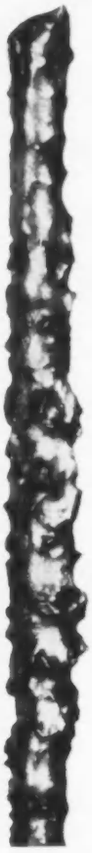
PATENTS APPLIED FOR

JOHNSTON TESTERS, INC.

P. O. BOX 98

HOUSTON 1, TEXAS

A and B "WEAR CUT"



The uniform cutting agent for fishing tools

A and B "Wear Cut," the newest addition to our tungsten carbide products family, is an effective cutting agent on rotary shoes, mills and reamers. It is manufactured under the most modern and efficient methods known in the Hard Metal Industry today. "Wear Cut" assures uniform grain size, eliminates flat slivers, and produces a rod with the **specified** amount of carbide and binder.

A and B "WEAR CUT" COMPOSITE ROD

ROD SIZE	MESH SIZE	% CARBIDE
3/16 x 15	10-18, 1/16-20, 1/8-1/16	60% ; 65%
1/4 x 15	3/16-1/8, 1/4-3/16	60% ; 65%
5/16 x 15	1/4-3/16, 3/16-1/8, 1/4-5/16	60% ; 67½%
3/8 x 15	5/16-1/4, 3/8-5/16, 7/16-3/8	60% ; 67½%

Write for prices on rods and/or bulk metal.

Engineering counsel is available. Let our tungsten carbide research center be your tungsten carbide center.

AND A B

Metal Mfg. Company, Inc.

Mfrs. of Tungsten Carbide

P. O. BOX 13125 HOUSTON 19, TEXAS

102

What's Happening among SERVICE and SUPPLY MEN

Bob R. Neal

Dick W. Johnson

Harley Sales Company has announced that **Bob R. Neal** was recently made president of the firm. It has also been announced that **Dick W. Johnson** has been promoted to general sales manager, and **John O. Moore** has recently joined Harley Sales as a sales engineer in Oklahoma, Kansas and Texas, with headquarters in Tulsa.

John O. Moore

Reed Roller Bit Company has announced that **William T. Adams** has been named Reed sales manager in Canada. Earlier in the year Adams became assistant to the Sales Division manager for the Southeastern Division which has offices in New Orleans.

Rodney Freeman has been appointed sales representative for **The Wheland Company.** Freeman will make his headquarters in Lafayette, La.

E. A. Booth

R. H. Martin

Jones & Laughlin Steel's General Sales and Tubular Products Division has announced the following changes in management personnel: **Russell F. Derr,** currently assistant general manager of sales, Detroit territory, will move to Pittsburgh to assume responsibilties there. **Edwin A. Booth,** Pittsburgh, has been appointed assistant general manager of sales. Booth formerly was manager of Tubular Products. **Roger H. Martin,** Pittsburgh, assistant manager, Tubular Products, has been appointed manager.

A. H. LeBleu of Houston has been named director of sales training for **Hughes Tool Company.** LeBleu, who joined Hughes in 1937, has been regional special representative in Houston since 1955. He will continue to make his headquarters in Houston.

Equipo Petrolero Ltda. of La Paz, Bolivia, has been named exclusive distributor for **Gardner Denver Company,** oil field equipment; **Cameron Iron Works; Hobart Bros.,** welding equipment; **Lufkin Foundry & Machine Company;** and **Reed Roller Bit Company** in that country.

Joseph A. Keeling, former supervisor for **Seismograph Service Corp.,** Tulsa, has been named manager of SSC of Argentina. Keeling will make his home in Buenos Aires.

W. E. (Abie) Best, Oklahoma City, has organized the **Best Well Servicing and Work-Over Company** which will engage in all phases of drilling, work-over and well servicing and production operations. Headquarters of the new company are at 805 SW 50th Street.

Dr. J. W. Jordon

Dr. John W. Jordon, technical director **Baroid Division National Lead Company** was awarded an honorary Sc.D. from Marietta College, Marietta, Ohio. Jordon graduated from Marietta College in 1934. He holds his Ph.D. in Chemistry from Columbia University.

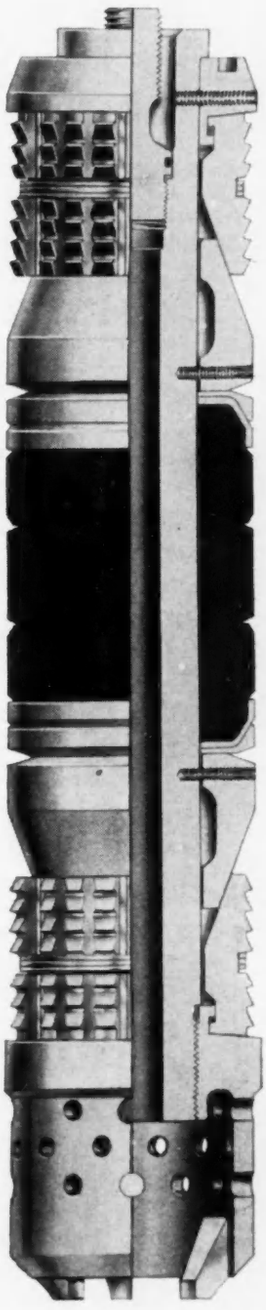
Norman Andrew has been appointed manager, operations of **Johnston Testers, Inc.** In his new capacity, he will be responsible for all oil field service activity of Johnston which includes drillstem testing, gun perforating, and downhole equipment for completion services such as acidizing, "squeezing" etc. Until recently, Andrew was manager of manufacturing.

Dowell Division of The Dow Chemical Company has announced several personnel advances in Tulsa recently. Joseph B. Stewart will take over the duties of district manager for Dowell's New Orleans district. **James S. Hobbs** also has been moved to New Orleans as the new district sales manager.

M. G. Purpus and **Newton D. Baker** have been elected vice president of **Black, Sivalls and Bryson, Inc.,** Kansas City, Mo. Purpus was elected vice president and manager of steel products sales, and Baker, former director of employe publication relations, has been appointed to the post of marketing vice president.

BETTER BRIDGING BENEFITS...
WITH
THE *NEW* HALLIBURTON

WIRE LINE BRIDGE PLUG!



A *NEW* short – compact casing bridge plug . . . covering a wider range of casing weights than any other bridge plug used in the field today . . . has been engineered and developed by HALLIBURTON.

Designed primarily as a wire line set plug and constructed of "drillable" cast iron with rubber seal elements . . . can be applied – regardless of depth or pressure – to provide a positive fluid "shut-off" from either direction. Presently available in 5½" O.D. 13-20 lbs. casing size only. Other sizes under development.

√ CHECK THESE OUTSTANDING FEATURES:

- Faster running-in time
- Reduced premature setting
- Less drilling-out material when removed from well

★★★ PLUS THESE SUPERIOR CONSTRUCTION FEATURES

Expanding metal shoes on each end form a bridge and prevent packer rubber from extruding over wedges under high pressures.

Rubber packer protected from deteriorating well fluids.

Wedges and top slip supports are shear pinned to mandrel to prevent premature setting while running in.

Equipped with junk pusher as standard part of bridge plug.

SETTING METHOD:

Halliburton Wire Line Bridge Plug is run on a sand or drilling line and set by either a Halliburton Hydraulic Wire Line Setting Tool or a Halliburton Cup Type Setting Tool . . . can also be used on electrical wire line – setting with Halliburton Powder Type Setting Tool.

Get additional information about this *New and Better bridging-tool* from your Halliburton Representative. Call him today for details.

HALLIBURTON
CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

"284 SERVICE CENTERS – JUST MINUTES AWAY FROM YOUR WELL"

Glenn E. Blackledge, former manager of Continuous Velocity Logging for **Seismograph Service Corporation** of Canada, has been elected vice president of the company in charge of Canadian operations, Calgary, Alta.

J. A. Harmon has been named manager of technical services, **Dowell Division of The Dow Chemical Co.**, Tulsa, replacing **Joe Stewart** who has been promoted to district manager at New Orleans for Dowell.

Clark Bros. Co., Division of **Dresser Industries**, has announced the appointment of **G. Berk Welch** as application engineer for the Clark Chicago district office.

A. K. Baebel

T. M. Short

A. K. Baebel has been appointed manager of export sales for the Western Hemisphere, and **T. M. Short**, Division engineer of the Northern Division of South America, for **Hughes Tool Company.** Baebel succeeds **O. B. Latrobe,** and Short replaces Baebel.

Stephen M. Jenks has been appointed executive vice president, engineering and research of **U.S. Steel Corporation.** Jenks succeeds **Walter F. Munford** who was elected president and chief administrative officer. At the same time, **Allen Clifford Johnstone** was appointed field representative for U.S. Steel's Oil Well Supply Division at Edmonton, Alta.; **Robert E. Beattie,** field representative at Beaumont, Texas, for Oil Well Supply Division, has been transferred to Laurel, Miss.; **J. P. O'Toole** has been appointed Eastern area manager at Columbus, Ohio; **William G. Smith, Jr.,** Eastern area district manager at Olney, Ill.; and **Paul B. Norton** has been appointed store manager at Laurel, Miss.

Frank Goldstone, who has retired at Shell Development Co.'s exploration and production research division, Houston, will move to London to represent **Petty Geophysical, Ltd.,** as vice president and managing director.

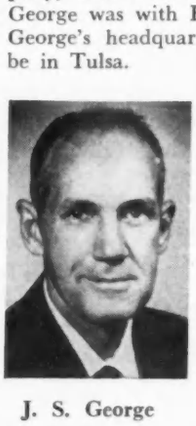
Wm. B. (Ben) Adair

Macco Oil Tool Company has named **William B. (Ben) Adair** assistant vice president. Adair will serve as director of engineering and products sales coordinator, assisting oil producers and Macco's distributors with engineering and product application problems. Adair will have his offices in Houston.

Richard C. Wood has joined **Texas Instruments Inc.,** as marketing manager, Advanced Technologies, in the Central Marketing Division.

Jones & Laughlin Supply Division has named three store managers. **Evan Smith,** assigned as store manager at Borger, Texas; **B. J. Ford,** Pampa, Texas; **W. T. Fleming,** promoted to store manager at Rangely, Colo.

J. S. (Dutch) George was recently appointed special representative for the **American Iron & Machine Works Company, Inc.** Prior to joining American, George was with Hughes Tool Company. George's headquarters and territory will be in Tulsa.

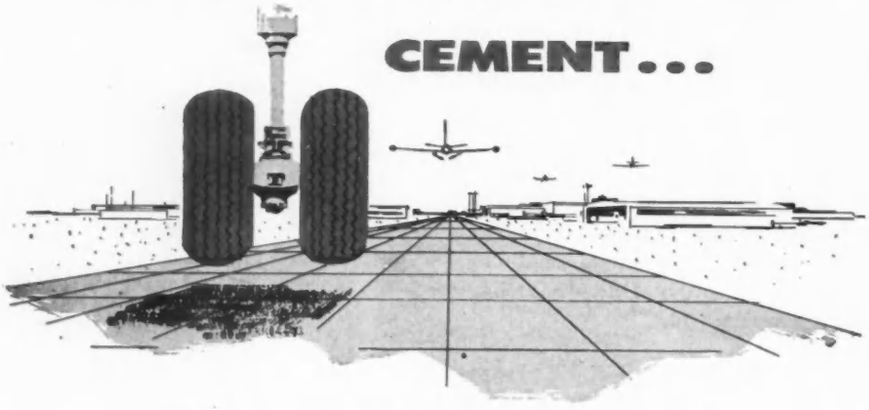


J. S. George

Jack R. Bechtold

Continental-Emsco has announced the appointment of **Jack R. Bechtold** as manager of Structural sales. He will headquarter at Emsco's Dallas office.

THERE ARE ALL KINDS OF CEMENT...



BUT JUST ONE BEST CEMENT ADDITIVE FOR OIL WELLS!

ONLY Strata-Crete 6 ® TRADE MARK GIVES YOU ALL 6 !

This improved perlite cement additive generally ***lowers fill-up cost,*** and is ***easier to place*** (requires only normal pump pressures). ***Superior bridging qualities*** and light weight assure complete fill-ups, and the greater resiliency ***reduces fracturing and shattering.*** Strata-Crete 6 can be used with ***any type or brand of cement*** and in itself is ***not affected by high well temperatures.***

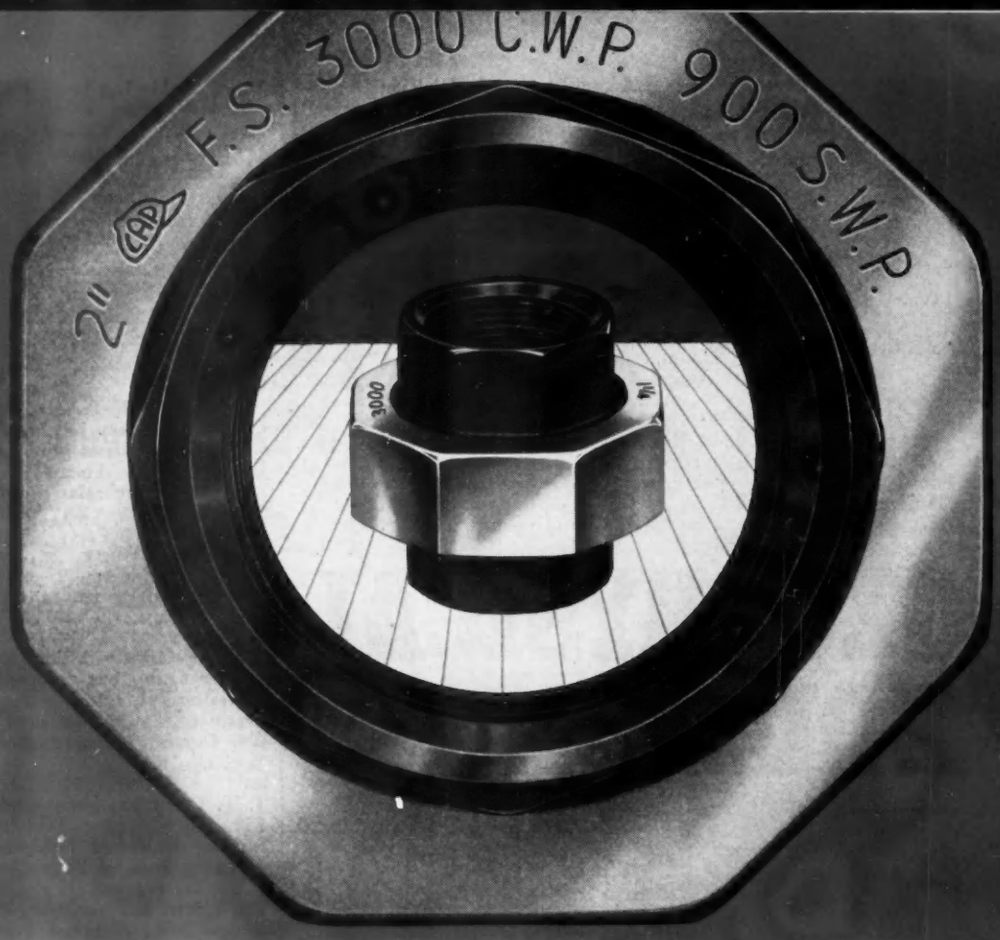
Strata-Crete 6 can be obtained from your oil well cementing service company.

GLC

GREAT LAKES CARBON CORPORATION

MINING & MINERAL PRODUCTS DIVISION — STRATA PRODUCTS DEPARTMENT

1404 NIELS ESPERSON BUILDING HOUSTON 2, TEXAS



COMPARE

CAPITOL FORGED STEEL UNIONS

...with any other union you may be using!

COMPARE the engineering and construction . . . ALL CAPITOL forged steel 3000# unions are made to AAR dimensions. Special attention is given threading, U. S. Army and Navy gauging practices on pipe threads guarantee better than normal industry standards. Burnished female seat increases surface hardness and prevents galling because of hardness differential, thus assuring a leak-proof joint regardless of repeated make-ups.

COMPARE material and quality . . . Capitol F. S. unions meet ASTM-A105 steel Grade II specifications. Each 3000# union is individually pressure tested to assure a leak-proof connection. Each is clearly identified for 3000# CWP or 900# steam pressure, size, and stamped with the CAP trade mark.

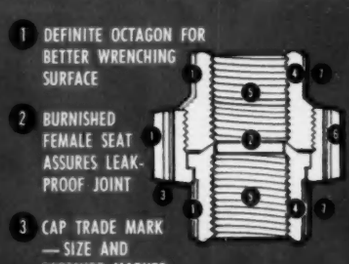
COMPARE finish and workmanship . . . Male and female parts are protected by phosphate coating, nut is Electro-Zinc plated. All three parts are sharply defined octagon shape for better wrenching surface.

Only by actual comparison can you fully realize the extra quality engineered into the Capitol 3000# F.S. union. Designed to meet the most exacting demands and produced by specialists to the highest standards.

You can depend on CAPITOL unions for your most critical installations.

Available in all sizes from ⅛" to 2" inclusive, either screwed or socket weld types. Conveniently packaged, for easy handling and inventory at no extra cost. Specify CAPITOL and COMPARE.

EACH INDIVIDUALLY PRESSURE TESTED


1 DEFINITE OCTAGON FOR BETTER WRENCHING SURFACE
2 BURNISHED FEMALE SEAT ASSURES LEAK-PROOF JOINT
3 CAP TRADE MARK — SIZE AND PRESSURE MARKED
4 HEAVY WALL TO EXCEED 3000# PRESSURE DEMANDS
5 EXTRA THREADS
6 ELECTRO-ZINC PLATED
7 PHOSPHATE COATED

SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS

COUPLINGS
NIPPLES — UNIONS
ELLS & TEES — PLUGS — CAPS
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CAP **CAPITOL**
MANUFACTURING CO.
DIVISION OF HARSCO CORP.
COLUMBUS, OHIO

G. R. King

J. C. Bonney

G. R. King has been appointed laboratory director and **J. C. Bonney** as assistant laboratory director of **Hughes Tool Company.**

Jones & Laughlin Supply Division has announced changes in its sales management group and new assignments for men in the field sales force. **Jack Judd**, manager, drilling equipment section, General Products Sales, has been promoted to assistant manager of sales, General Products; **C. E. Bogle**, manager, wire rope section, has been made manager, drilling Equipment. **R. J. Bevington**, formerly salesman at Freer, Texas, has been transferred to McAllen, Texas; **R. D. Landis**, was transferred from Alice to Freer; **C. L. Wallace**, Houma, La., has transferred to Brookhaven, Miss.; **B. W. Ramsey**, Lake Charles, La., transferred to Houma; **H. E. Reeves** has transferred to Natchez, Miss.; **D. R. McKnown**, Williston, N.D., transferred to Houston; **P. A. Toomey**, storeman at Williston, N.D., was promoted to salesman, and **T. D. Gholson** has been assigned as salesman at the Houston sales office.

Wiley Noble has been appointed director of engineering for **Emsco Screen Pipe Company of Texas.** Noble has previously been employed as vice president in charge of engineering at Reed Roller Bit Company. Noble will make his offices at the company's Houston headquarters.

Wiley Noble

Clyde M. Lackey has been appointed sales manager of **Franks Division, Cabot Shops, Inc.**, Pampa, Texas. Lackey was formerly with the sales division of Cardwell Mfg. Co.

Charles L. Power, Jr., will be **Dowell's** new district manager in the Shreveport, La., district. He moves to Shreveport from New Orleans.

Maloney-Crawford Tank and Manufacturing Company has announced the election of **Willard H. Land** to the position of vice president and general sales manager. Land was formerly with Parkersburg Rig and Reel Co.

J. T. Furry has been appointed sales representative in the Midland, Texas, area for the **Diamond Equipment Division of Hycalog, Inc.**, of Shreveport, La.

Bill Crowl has announced the opening of a new firm, **National Pipe Testers, Inc.**, of which he is president. The firm is licensed by **Lynes, Inc.**, of Houston, has been formed with headquarters in Odessa, Texas, to specialize in hydrostatic pressure testing of oil well tubing, drillpipe and casing.

Galen T. Brown

Floyd A. Cailloux

Systems Engineering and Manufacturing Co., Inc., is a newly formed company with home offices in Houston. **Floyd A. Cailloux** is president of the new company and **Galen T. Brown** is executive vice president. The new company will specialize in the design and fabrication of bulk equipment for the petrochemical and cement industries.

Tex-Tube, Inc., has announced the election of **I. W. Shaw** as vice president, Production. Shaw's previous position was manager of Operations.

W. C. Talbert has been appointed director of Foreign Sales and **Louis M. Kraussee** has been named director of engineering for the **Mission Manufacturing Company.**

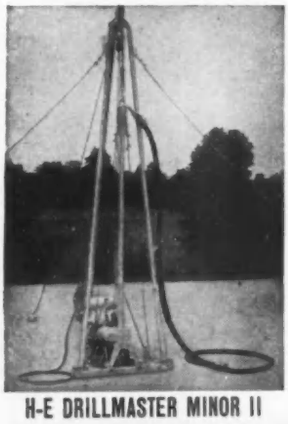
Stewart & Stevenson Services, Inc., has named **Joe Terrell** as sales engineer and **Harry Barker** was appointed assistant to the factory superintendent.

H-E GEOPHYSICAL EQUIPMENT

H-E TRACTOR DRILLMASTER

H-E manufacture a wide range of Geophysical supplies in addition to that illustrated including: loading poles, cable reels, winches, shooting trucks etc. Write for full details quoting ref.D/GL.

H-E TRUCK DRILL



H-E DRILLMASTER MINOR II

H-E RECORDING CAB

H-E BREAST REEL

H-E WATER TRUCK

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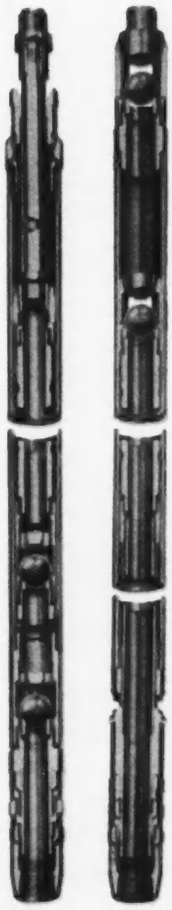
AXELSON SURE-SEAL

The Axelson "Sure Seal" RWA, RWB, and RWT are the most widely accepted pumps in the Axelson line. This popularity is contributed in part to these features: Economy; complete interchangeability of parts; long dependable service; and the variety of plunger and tube combinations available.

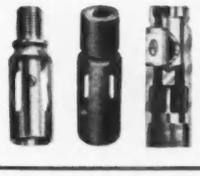
RWB – This "Sure Seal" (Bottom Hold Down) pump with stationary barrel is available with either 3-cup Hold Down Body Assembly (for seating nipple) or API Bottom Lock Mechanical Hold-Down (for mating shoe in tubing string).

RWA – This "Sure Seal" (Top Hold Down) pump with stationary barrel is preferred where sand and gas are present. Available with Top Hold-Down or Axelson Mechanical Top Lock Assembly, the pump provides improved gas separation and free entry of fluid into the producing chambers.

RWT – This "Sure Seal" traveling-barrel type pump is available for operators who prefer the traveling-type pumps for their particular well condition.



RWB RWT



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Axelson offers open and closed cages for all types of pumps as both working and standing valves. All are of rugged construction and machined from high-quality alloy steel to provide maximum strength and wear resistance.

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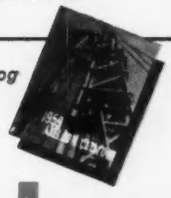

USI Axelson

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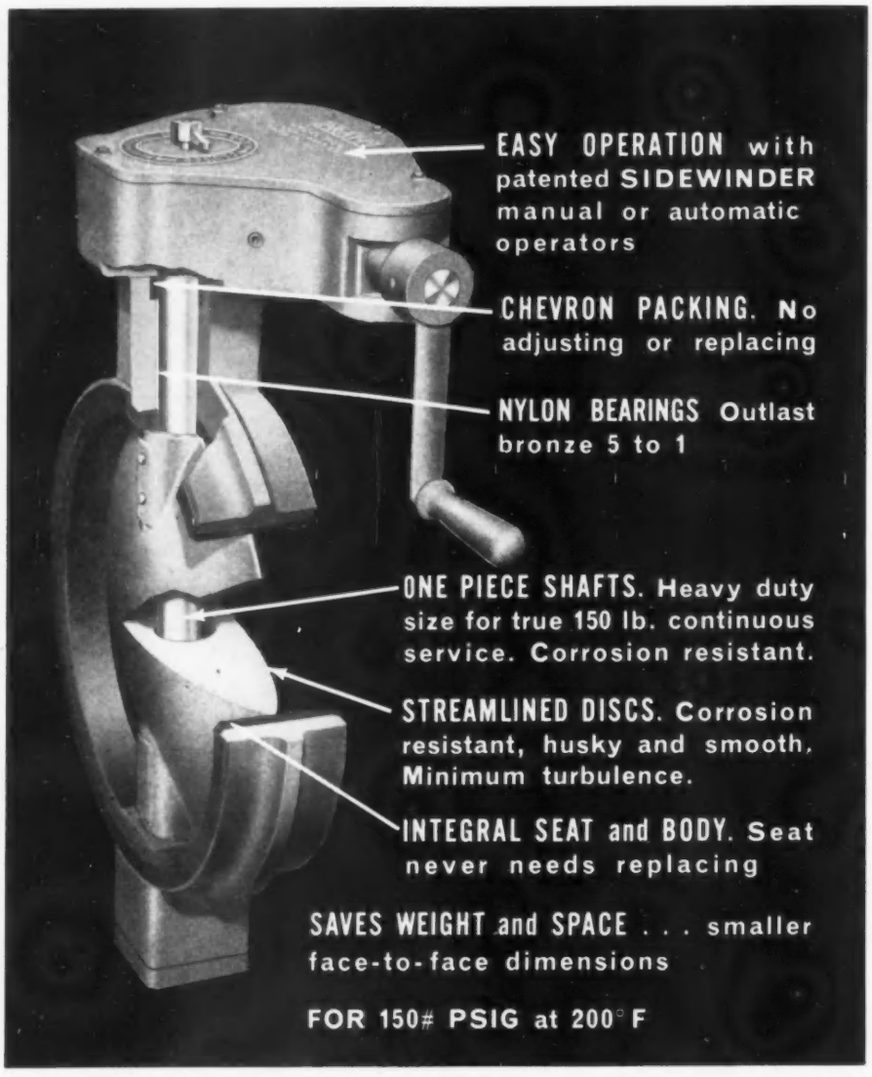
EASY OPERATION with patented SIDEWINDER manual or automatic operators
CHEVRON PACKING. No adjusting or replacing
NYLON BEARINGS Outlast bronze 5 to 1
ONE PIECE SHAFTS. Heavy duty size for true 150 lb. continuous service. Corrosion resistant.
STREAMLINED DISCS. Corrosion resistant, husky and smooth. Minimum turbulence.
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SAVES WEIGHT and SPACE . . . smaller face-to-face dimensions
FOR 150# PSIG at 200° F

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The MONOFLANGE MARK II is built for tight shut-off at 150 lbs., is ideal for throttling service, and versatile in application.

This is a Henry Pratt *Market Oriented* product . . . ALL NEW . . . built to answer industry's specific needs for this type of valve.

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Representatives in Principal Cities

J. W. Cooper

Jimmy Helton

George E. Failing Company has announced the appointment of **J. W. Cooper** as manager of the Failing Company's Canadian subsidiary, the **George E. Failing Supply Company, Ltd.**, of Edmonton, Alta. **Jimmy Helton**, who managed the Failing Canadian subsidiary in the past has been made West Coast district manager with headquarters in Oakland, Calif.

Jones & Laughlin has made three changes affecting management personnel in the General Sales Office and Tubular Products Division. **Russell F. Derr**, Birmingham, Mich., currently assistant general manager of sales assigned to the Detroit territory, is to move to Pittsburgh to assume responsibilities there. **Edwin A. Booth**, Pittsburgh (Mt. Lebanon), manager, Tubular Products, has been appointed assistant general manager of sales. **Roger H. Martin**, Mt. Lebanon, assistant manager, Tubular Products, has been appointed manager.

Vern Cutchall has been appointed Houston sales representative for **Iverson Supply Company.**

The Koppers Company, Incorporated, Metal Products Division, has announced the appointment of the **George J. Fix Company** as exclusive sales agents in the North Texas area for their line of fast couplings.

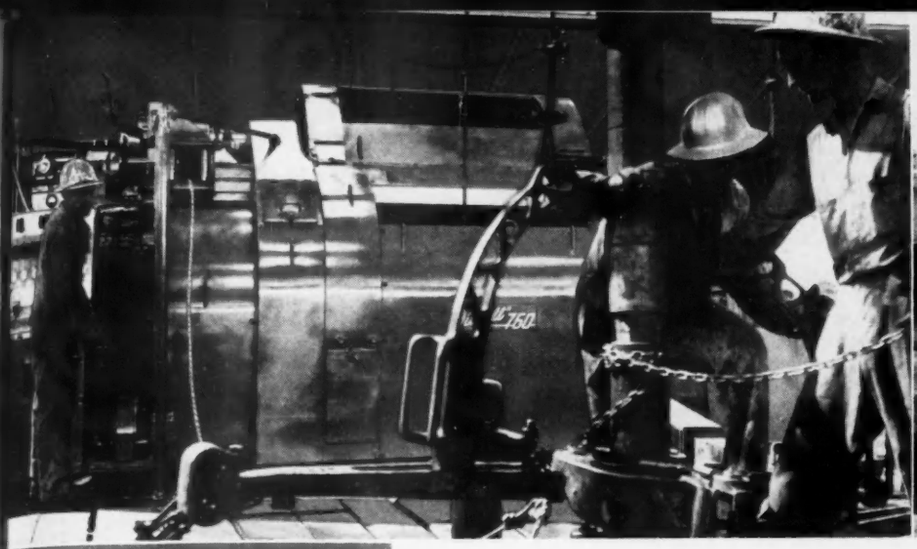
Stanley J. Mead

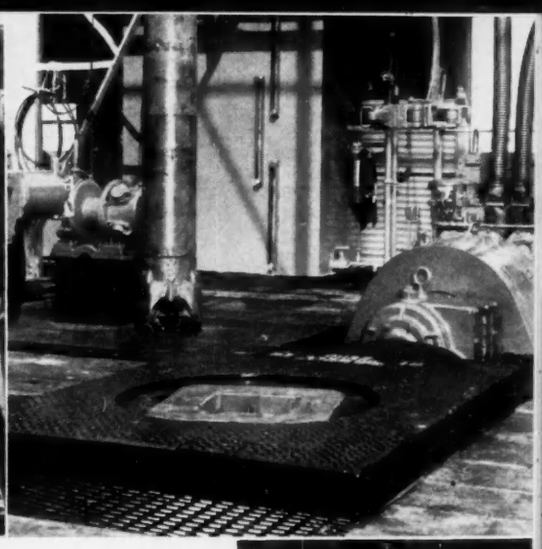
The Bovaird Supply Company has announced a further expansion in their territory and service. A new store in Natchez, Miss., has recently been opened and **Stanley J. Mead** has been named as store manager. District office for the area is in Shreveport, La., under the supervision of **Ralph J. Enloe**, district manager.

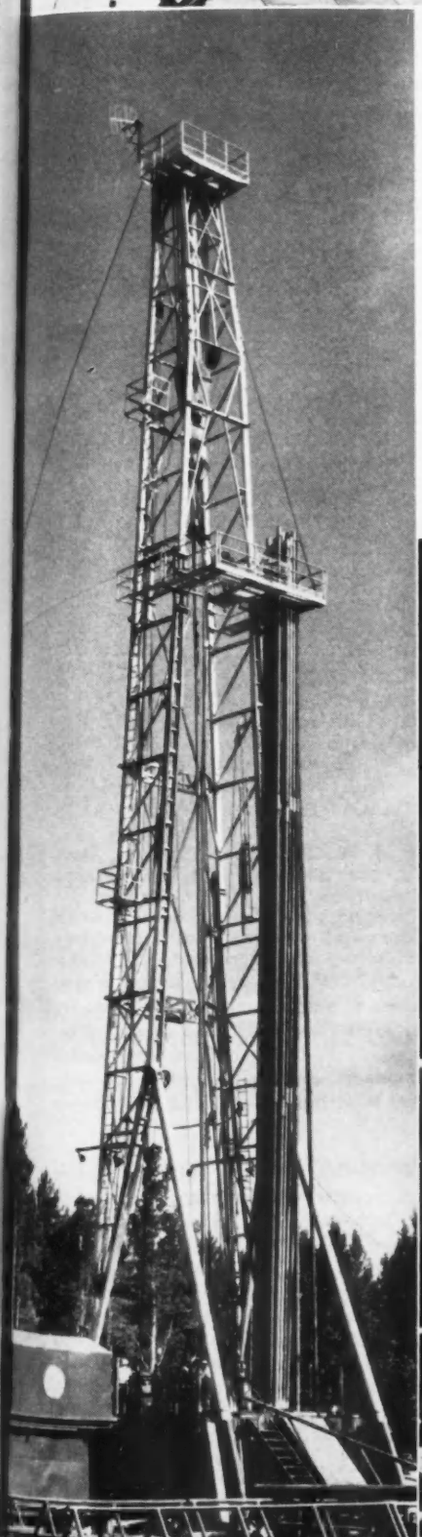
C. Ross Spencer was recently appointed to the newly created position of manager, special projects for **W-K-M, a Division of ACF Industries.**

Craig Smyser has joined **Continental-Emsco Company, a Division of The Youngstown Sheet and Tube Company,** as vice president in charge of Special Projects and Services. Smyser previously was vice president in charge of operations for Paul Hardeman, Inc.

Cameron Iron Works, Inc., has announced the appointment of **Roy Davis,** formerly sales manager of the Valve and Oil Tool Division, as manager of the Pressure Control Equipment Division.







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Wilson Supply Co. is an authorized distributor for the complete line of "Oilwell" drilling machinery. For any item of drilling equipment, contact your Wilson Supply man to be sure you get what you want . . .

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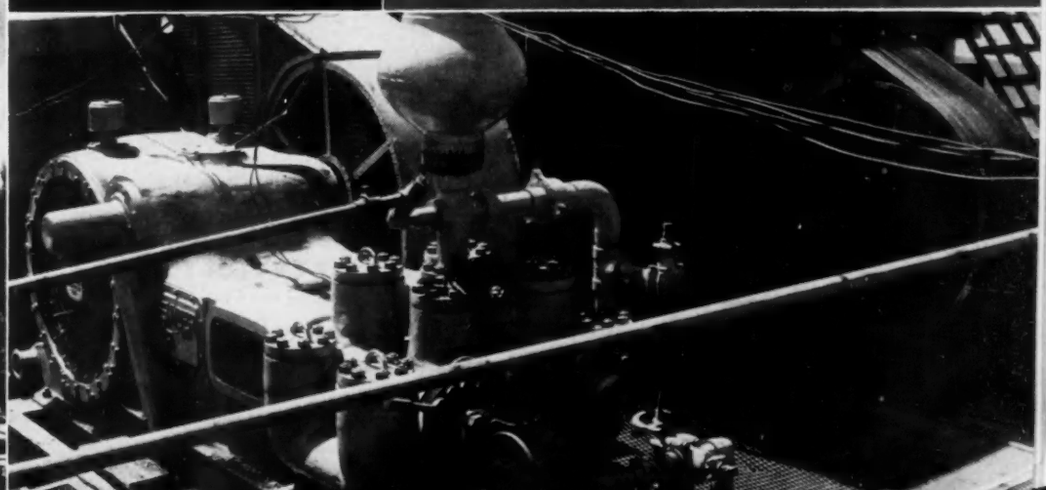

Max C. Tomlinson has recently joined **Technical Oil Tool Corporation** as a TOTCO service representative in the Hobbs, N. M. area.

Chain Belt Company has recently announced the election of **George H. Woodland**, vice president, Marketing, to its board of directors.

John O. Moore, formerly a sales engineer with the Worthington Corporation, has recently joined the **Harley Sales Company** as a sales engineer in Oklahoma, Kansas and Texas, headquartering in Tulsa.

Garrett Oil Tools, Division of U. S. Industries, Inc., has announced the appointment of **K. J. Walker** as manager of South American Sales. Walker will make his office in Caracas, Venezuela.

H. T. (Hugh) Harvey has been named operations manager of **Welex of Canada Ltd.** Harvey will establish a new office in Edmonton, Alta., in order to expand the company's services in Northwest Canada. It was also announced that **S. H. (Stan) Nelner**, former operations manager, has been named vice president for operations and will continue to headquarter in Calgary.

H. T. (Hugh) Harvey

Z. B. Deer, Jr., has been appointed sales engineer for **Clark Bros. Co.** in the Texas-Oklahoma Panhandle area. He was formerly chemical division supervisor with the Celanese Corp.

Schlumberger Well Surveying Corporation has announced the appointment of **E. A. Colle, Jr.**, to the position of manager of Schlumberger South Texas Division at Corpus Christi, Texas.

Lane-Wells Company, a Division of Dresser Industries, Inc., has named **John C. Stick** assistant manager of Logging Services. Stick was technical director of Well Surveys, Inc.

John C. Stick, Jr.

S. M. Dippel

S. M. Dippel has been appointed salesman for **Jones & Laughlin Supply Division** at Victoria, Texas. Dippel attended Southern Methodist University and entered the company's sales training program in July 1957.

Baash-Ross Division of Joy Manufacturing Company has been named domestic distributor for **Derrick String-a-lite** assemblies for masts and derricks. Manufacturing will continue to be done by the Electrical Products Division of Joy Manufacturing Company in St. Louis, Mo.

Claude L. Doughman, Jr., has joined the Steel Pipe Sales Division of **Lone Star Steel Company** and will work with District Sales Manager **Robert Reed** in the Houston office.

Southern Engine & Pump Company has announced the appointment of **B. E. Ballard** as purchasing agent for that company. Ballard was formerly in the Billing Department. He will continue to reside in Houston.

Fenton M. Wood has been appointed manager of the Research and Development Department of **Tuboscope Company.** He will supervise the development of new techniques and equipment for Tuboscope's nondestructive inspection services for tubular goods. At the same time, **Wayne Thompson** was appointed division manager of the West Texas Division of the firm. Thompson had been working as division sales manager and assistant division manager in West Texas, prior to his promotion.

John C. Helies has been appointed president of **Security Engineering, Division of Dresser Industries.** Two other appointments have been announced by Security. **A. R. (Pat) Patton** was named division special sales representative, working primarily in Southern Louisiana, Mississippi and Alabama; **Claude L. Griffin** was appointed president in charge of sales. Griffin was elevated from the position of domestic sales manager.

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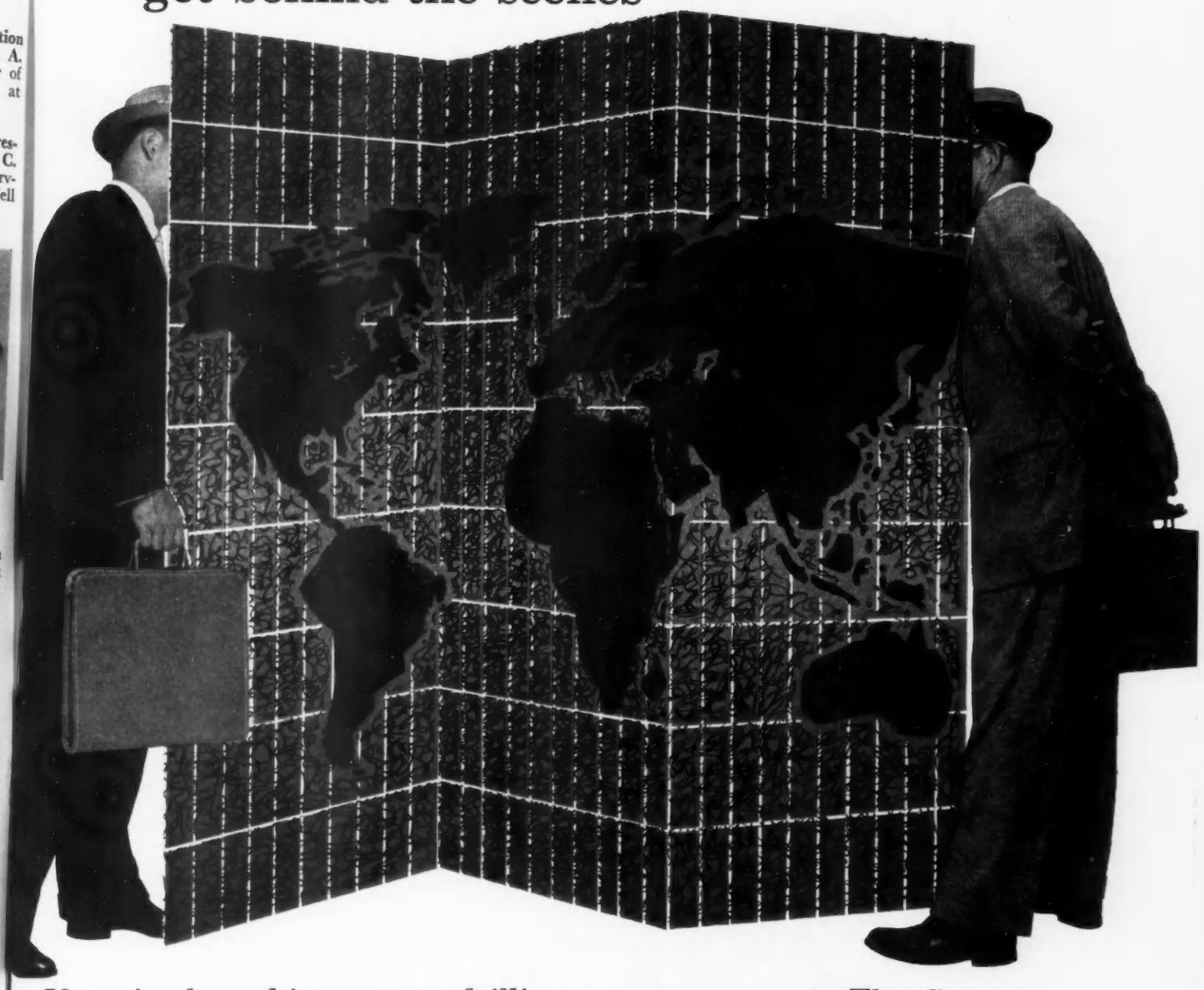
get behind the scenes



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George Yoakum has been appointed district engineer of **Sargent Engineering Corporation** with headquarters in Midland, Texas. Yoakum's assignment is part of Sargent's campaign to provide additional services to producers of the West Texas area. Yoakum has been employed with the Fullerton Oil Company, Hobbs, N. M., prior to joining Sargent.

George Yoakum

Clever-Brooks Company have announced the appointments of **Thomas B. Mansfield** and **Richard D. Pennstrom** as regional managers as a part of a major sales realignment.

C. M. Peters has been appointed vice president, Sales Engineering, by the **Garrett Oil Tools, Division of U. S. Industries.** In his new position, Peters will be in charge of Garrett's Operations in Europe and the sterling currency areas.

Black, Sivalls & Bryson, Inc., has announced the following executive promotions: **Charles H. Myers,** vice president and manager of the Oilfield Equipment Division, to vice president, Industrial Relations; **Floyd C. Myers,** from manager of Oilfield Sales and Service, to vice president, serving in a staff capacity; **Paul Bartley,** vice president and general manager of Black, Sivalls & Bryson, Ltd., Edmonton, Alberta, to manager of the Oilfield Equipment Division, Oklahoma City.

Republic Steel Corporation has announced the transfer of **Henry A. Bourne,** formerly Pacific Coast sales manager, to Tulsa as district sales manager, succeeding **Charles W. (Chuck) Kennedy,** promoted to sales manager for the Houston district.

Fred Jackson

Joe F. Bealer, Jr.

Baash-Ross, a Division of Joy Manufacturing Company, has announced the appointment of two new field salesmen and the transfer of one to a new station. **Fred Jackson** has been transferred from Casper, Wyo., to Liberal, Kan., as a salesman. **Joe F. Bealer, Jr.,** replaces Jackson in the Baash-Ross Casper office. **Leon McRae Gay** joins Baash-Ross as a salesman at the Odessa, Texas, office.

Leon McRae Gay

Schlumberger of Canada, a Division of **Schlumberger Limited,** has announced the following appointments: **L. G. Chappel** has been transferred to the Schlumberger Well Surveying Corporation as division manager, Oklahoma Division, Oklahoma City; **W. T. Wilson** replaces Chappel at Regina, Canada, as Eastern Division manager; **W. S. Jones** has been appointed assistant to the vice president, Schlumberger of Canada; **B. M. McVicar** has been appointed general manager of sales and heads the newly formed department which will direct sales for the Canadian company; and **L. V. Carson** has been appointed Eastern Canada Division manager based at Calgary.

Charles Spitzfaden

J. A. Whitesides

Continental-Emsco Company has announced the appointment of **Charles Spitzfaden** to the position of general manager of sales, Non-Tubular, and **J. A. Whitesides** to manager of Drilling Equipment Sales Department.

Hughes Tool Company has organized an Industrial Sales Section and **S. B. (Sid) Plummer, Jr.,** has been named coordinator of industrial sales. **Leon B. Stinson** has been named manager of the new section and **Roy M. Goolsbay** named as assistant to the manager.

A "Pit-O-Graf" MIGHT HAVE SAVED THIS WELL

A Pit-O-Graf can give adequate warning to prevent a blowout. But, it must be where the driller can see it, can take advantage of it. Here's what users have to say:

One oil company says — "Although blowout prevention is a matter of concern for the operator, the contractor, and the drilling crews, generally *the driller is the key man.*"

Another company says—"Since a pit level indicator is so important, take these precautions to get the most good out of it: Place the pit level recording instrument at or near *the driller's position on the derrick floor.*"

If the driller's responsibility is not misplaced, then he can recognize the danger signals that precede every blowout. With the Pit-O-Graf record before him, he can intelligently analyze the *rate* of gain or loss of mud as recorded and thereby direct his crew in the orderly control of the situation at hand. In this case the threatened blowout would become *one that does not happen.*

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F. W. Benzley has been transferred by **Schlumberger Well Surveying Corporation** from Medicine Lodge to Pratt, Kan., as location manager. **G. G. Kemp,** Shawnee, Okla., has been transferred to Pratt as sales engineer.

Vern Cutchall has been appointed as Houston sales representative for **Iverson Supply Company** which has opened a new sales office in the First City National Bank Building in Houston.

N. W. Mann has been named vice president in charge of U.S. and Canadian operations for Geophysical Service, Inc. **G. J. Kohler, Jr.,** who has been manager of GSI operations in Latin America has been elected vice president in charge of that area. **Ray H. Wright,** who has been serving as manager of GSI's Canadian operations has moved to Dallas to take over the position vacated by Mann. Wright, in turn, has been succeeded in Canada by **Dan F. Brennan.**

L. A. Ffrench

Harry A. Cecsarini

Cooper-Bessemer has announced three new appointments. **Leopold A. Ffrench** was appointed to the office at New York City. He will work directly under **Charles G. Cooper,** president, and will devote his attention to the application and sale of engine-driven and motor-driven compressors for overseas installation. **Earl Martin** was appointed to the position of branch manager of the Houston office, filling the post vacated by the retired **R. H. Vales. Harry A. Cecsarini** was named to the post of European manager of Cooper-Bessemer, S.A., a Swiss company incorporated in Shur, Switzerland, with offices at The Hague, Netherlands.

American MARC Inc., California manufacturer of diesel engines, natural gas engines, generators and generator sets, has appointed **Allied Diesel Sales and Service, Inc.,** Boston, Mass., as exclusive distributor for the states of Massachusetts, Rhode Island, New Hampshire and Connecticut.

J. R. Johnston has been appointed assistant treasurer, **Jones & Laughlin Steel Corporation,** and credit manager, **Jones & Laughlin Supply Division.** Johnston succeeds the retired **P. R. Warner. E. H. Moores** succeeds Johnston as attorney.

U.S. Steel's Oil Well Supply Division has made the following appointments: **Jackie Ray Hunnicut** as field representative, Hobbs, N.M.; **Bruce L. Rhea** as field representative at Gainesville, Texas; and **Ben A. Brooks, Jr.,** city representative, Midland, Texas.

Herbert R. Trantham, Jr., has been named store manager at New Iberia, La., and **Charles T. Lathrop, Jr.,** as district engineer at New Orleans, for the **U.S. Steel's Oil Well Supply Division.**

T. W. Cole has been promoted to Rocky Mountain Area manager with headquarters in Casper, Wyo., for **Johnston Testers, Inc.** Prior to joining Johnston, Cole was a driller for both F. M. Manning Drilling Company and Brinkerhoff Drilling Company. Cole joined Johnston Testers in 1950.

T. W. Cole

Continental-Emsco Company has opened a new store at Lafayette, La. **Frank Ellis** has been appointed store manager.

Mandrel Agrees to Purchase Well Instrument Developing Co.

Mandrel Industries, Inc., has entered into an agreement to purchase all of the outstanding common stock of the Well Instrument Development Company of Houston.

WIDCO's facilities and personnel will be integrated with Mandrel's Electro-Technical Labs Division, under the management of D. D. Mize, Mandrel vice president.

Hubert Guyod, formerly with WIDCO, will join Mandrel's ETL Division and will be placed in charge of all matters relating to well logging equipment and instrumentation.

Tight Seal
ASSURED
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Hardy-Griffin
GT-API Modified
Couplings
Leak-tight coupling joints are assured and no joint strength is lost with the GT-API modification in the Hardy-Griffin Teflon* sealed couplings.
While recommended for all API tubing and casing applications, the GT seal is particularly valuable where high pressure or resurgent shock is a problem.
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*DuPont's Tetrafluoroethylene Resin

For more data on advertised products, use Readers' Service Cards, last page.

ALCOA Plans Installation Of 5,200-Ton Extrusion Press

Aluminum Company of America has revealed plans to install a 5,200-ton capacity extrusion press at its Vernon, Calif., works as a heart of a multi-million dollars expansion program.

Installation of the big press was scheduled to start in the latter part of July with plans of the new facility to be ready for production early in 1960.

Included in the $5-million expansion program are a new building to house the press, and a 750,000-pound capacity stretcher, which was installed last year.

Expansion of extrusion operations is one point in Alcoa's long range program for improving facilities at the Vernon works. Started in 1954, the program includes a $4½ million expansion of forging operations and modernization and streamlining of casing facilities.

New Distributor Named By Bucyrus-Erie Company

Union Pipe & Supply Company, following its merger with Cable Tool Supply Company, has been appointed a distributor for the complete line of water and oil well drills and parts and tools manufactured by Bucyrus-Erie Company, Drill Division.

The new distributor team will cover a four-state territory which includes western Kentucky (including the current "oil boom" counties of Green, Taylor, Metcalfe and Monroe); eastern Tennessee; southern Indiana and southern Illinois. This area was previously served by Cable Tool.

Union Pipe and Cable, as the new distributors, will handle parts in addition to a stock of drilling and fishing tools. Service facilities also will be maintained at the distributor's office and shop in Owensboro, Ky.

Mandrel Acquires Assets of Texas Division of Clevite Corp.

Mandrel Industries, Inc., has entered into an agreement to purchase substantially all of the assets of the Texas Division of the Clevite Corporation.

Clevite manufactures a complete line of seismic exploration instruments in its Texas Division, formerly known as the Texas Division of Brush Electronics Company, a Clevite subsidiary.

Mandrel will merge the facilities thus acquired with its Electro-Technical Labs Division, Houston, under the direction of D. D. Mize, vice president and general manager of Mandrel's Houston operations.

Perfect Circle's Cosasco Division Purchased by Grant Oil Tool Company

Grant Oil Tool Company has acquired the assets and inventories of Perfect Circle's Cosasco Division, according to a recent announcement by William B. Prosser, president of Perfect Circle Corporation, and Albert Salvatori, vice president of Grant Oil Tool Company.

According to the announcement by Salvatori, the new acquisition will be known as Cosasco Division of Grant Oil Tool Company.

Waukesha Motors Represented in South America by U. S. Industries

Oil Field Sales & Service, S.A., a subsidiary of U.S. Industries, Inc., has been appointed exclusive sales and service representative in eastern Venezuela and in Colombia for the Waukesha engine line of Waukesha Motors, Ltd.

In addition to the Waukesha engine line, Oil Field Sales & Service, S.A., will distribute and service engines made by Waukesha's Roiline and Climas Divisions throughout the two South American countries.

To coordinate servicing and maintenance of the Waukesha engines, Oil Field Sales & Service, S.A., has appointed Delmar Schmidt to direct its Engine Field Maintenance staff. He will supervise this operation from Anaco, Venezuela.

Tuboscope Now Offering Inside Plant Inspection Service

The first inspection service inside a plant ever to be offered, according to the company, is now available in Midland, Texas, from Tuboscope Company.

Located adjoining the new Tube-Kote, Incorporated facilities on Tower Road, the new Tuboscope plant inspection facilities are completely automatic, according to J. W. Bozeman, president of the company. "The inspection techniques are the latest products of Tuboscope research, and include Sonoscope inspection of used tubing which provides 100 percent inspection of the tubing wall and defective pieces are quickly spotted," says Bozeman.

The new inspection facilities are centrally located in the Permian Basin and provide Tuboscope's inspection service to customers in this area.

Photo Courtesy of Shell Oil Company

WISCONSIN-POWERED *Sea-Going "David Buggies" Expedite Under-Water Exploration*

Shown above is a specially designed sea-going "David Buggy" tractor working with an aquatic shot-hole rig in a shallow bay on the southwest coast of Texas. The drilling rig is mounted on a trailer fitted with aircraft tires. The "David Buggy," supplied by the Applied Research Development Co., of Houston, Texas, is powered by a 4-cyl. 30-hp. VH4D Wisconsin Heavy-Duty Air-Cooled Engine. The tractor rides on extra-wide, hollow-metal wheels . . . heavily cleated for traction in soft mud.

This is a more or less typical application of WISCONSIN Engine Power to the many and varied power jobs connected with oil-field operations. Whether operating oil pumps, pipeline units, salt-water disposal pumps, pipe-bending machines, mud "bazookas," dope kettles, pipe-testing equipment, air compressors, standby power units or any of a great diversity of oil-field utility units . . . Wisconsin Air-Cooled Engines meet the power demands of the job and the equipment.

Available in a complete power range from 3 to 56 hp., in single cylinder, 2- and V-type 4-cylinder models, these heavy-duty engines have what it takes for rugged service under *your* conditions . . . in any location, under any climatic conditions. You get full-time load-lugging power, low-cost operation and maintenance, and long engine life. Good reasons why it pays to specify "Wisconsin" for your equipment.

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BOOKS

A HABITAT OF OIL, American Association of Petroleum Geologists, Box 979, Tulsa 1, $11, ($9 to AAPG members).

Papers presented at the fortieth annual meeting of the AAPG in New York March 28-31 and some additional papers are presented in this volume. Lewis G. Weeks analytically reviewed and edited the publication.

The book is an analysis of facts, interpretations, principles and theories presented in the symposium. North and South America, topical papers, modern basins, Europe, the Middle East and the Far East are subjects covered in the book.

CORROSION OF OIL- AND GAS-WELL EQUIPMENT, American Petroleum Institute, 300 Corrigan Tower Building, Dallas 1, $2.50.

The American Petroleum Institute's recent publication "Corrosion Of Oil- And Gas-Well Equipment" is directed at field operating personnel and makes full use of the simplest possible terms and descriptions. Embodied in the book are pictures and diagrams of typical control measures.

Knowledge and attitudes specifically mentioned are appreciation of the enormous cost of oil-field corrosion; ability to recognize early indications of corrosion; awareness of the importance of early reporting; and desire to take effective part in the solution.

SIXTH ANNUAL INSTITUTE ON MINERAL LAW, Louisiana State University Press, Baton Rouge 3, La., Published Sept. 1, 1958, $7.50.

The Mineral Law Institute is now an established program of the Louisiana State University Law School in continuing legal education. The Sixth Annual Institute presented a panel of papers dealing with oil and gas law. Harriet S. Daggett, professor of law at the University was the moderator.

The book was published for the Louisiana State University Law School and the General Extension Division.

APPLIED PETROLEUM RESERVOIR ENGINEERING, Prentice-Hall, Inc., publishers, 70 Fifth Avenue, New York, N. Y., B. C. Craft and Murray F. Hawkins, Jr., $12.00.

Up-to-date, this new book makes a significant contribution to the need of improved scientific methods for the analysis and prediction of reservoir and well performance. Terminology such as standard AIME reservoir engineering symbols and practical units, this compact but comprehensive guide also deals with such topics as Gas Reservoirs, Gas Condensate Reservoirs, Undersaturated Oil Reservoirs, Oil Reservoirs Under Simultaneous Dissolved Gas Drive, Gas Cap, and Water Drive, Water Flux, Fluid Flow in Reservoirs, The Displacement of Oil and Gas.

Abundantly illustrated with basic graphs, charts, line drawings, tables, and examples, plus 182 problems, the material of this volume has been class-tested. Every topic is covered clearly and thoroughly to give the reader the sound background in fundamentals needed to solve more specialized and complex problems of well and reservoir behavior.

THE EARLY HISTORY OF THE HOUSTON OIL COMPANY OF TEXAS 1901-1908, Texas Gulf Coast Historical Association Publications, John O. King, $3.

This paper-bound book traces the development of the Houston Oil Company from its formation in 1901, through years of financial instability, receivership and litigation, to 1908 and its emergence as a substantial corporate entity.

Included in the book are illustrations of John Henry Kirby in his later years, map of land holdings in East Texas and an illustration of Patrick Calhoun, promoters and organizers of the Houston Oil Company. Also, a table showing properties acquired through Kirby and Calhoun, their purchase price and method of paying.

GEOCHEMICAL METHODS OF PROSPECTING AND EXPLORATION FOR PETROLEUM AND NATURAL GAS, Berkeley and Los Angeles University of California Press, A. A. Kartsev, Z. A. Tabasaranskii, M. I. Subbota, and G. A. Mogilevskii, English translations by Paul A. Witherspoon and William D. Romey, $12.50.

This volume not only describes all the geochemical methods used in prospecting and explorating for petroleum in the Soviet Union, it also interprets results and correlates them with data obtained from other procedures, and cites examples in which such methods have been successfully utilized in the discovery of oil and gas pools.

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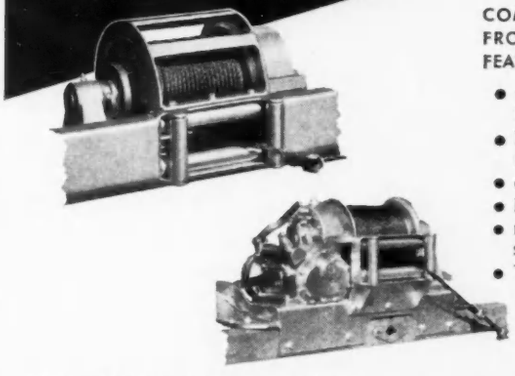

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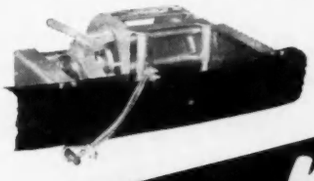

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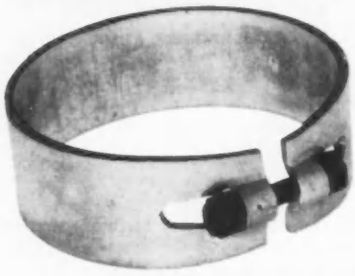

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SQUEAKS from the BULLWHEEL

WORLD OIL

"Milly really cooked up something this time Boss!—A new type drilling mud."

What Will People Think

"Good heavens!" cried Whistler as he saw his mother on her knees scrubbing the floor. "Have you gone off your rocker?"

Today's Fashions

A salesgirl was describing a new four-piece outfit a model was wearing: "If you remove the bodice you have a playsuit. If you remove the skirt, you have a sunsuit. If you remove anything else, you have a lawsuit."

He Was Shotless

"Was her father surprised when you said you wanted to marry his daughter?"

"Was he surprised? Why the gun fell right out of his hands."

Gunsmoke

Captain to Rookie: "Don't you know better than to point an unloaded gun at me?"

Rookie to Captain: "But, sir, it isn't unloaded."

She's Funny That Way

A drunk hanging on a lamp post was approached by a kindly old lady who asked, "My good man, why don't you take a bus home?"

The imbiber answered: "Shno use. Wife'd never lemme bring it in the housh."

It's a Mystery

Wife of Lush: "Husband, how do you suppose those empty bottles got into our basement?"

Husband: "I have no idea—I never bought an empty bottle in my life."

In the Old Days

A posse had just captured a hoss thief and were preparing to string him up. One member of the crowd spoke up, "May I say a prayer for this man?"

The deputy in charge of the posse protested vigorously. "Are you trying to sneak this varmint into Heaven when he ain't even fit to live in Texas?"

Special Request

Hostess: "I hope my husband wasn't rude when he asked you to play."

Pianist: "Oh no, he only asked that I do not play one tune."

Hostess: "And what was that tune?"

Pianist: "He said don't play 'For the Love of Mike'."

A True Disbeliever

Teacher: "Johnny, if I lay two eggs here and three there, how many will there be altogether?"

Johnny: "Personally, I don't think you can do it."

20/20 VISION...

The field of nuclear logging received its greatest advancement when McCullough introduced the Scintillometer back in 1949.

This super-sensitive crystalline detector really gave 20/20 vision to the science of well logging – enabling the operator to see and interpret the nature of the formations surrounding the well bore with greater clarity and in more detail.

McCullough Nuclear Well Logging with the Scintillometer (scintillation spectrometer) has been refined and improved year after year. It is the accepted standard of the industry, giving you more down hole data with greater accuracy – unquestionably the best nuclear logging service available.

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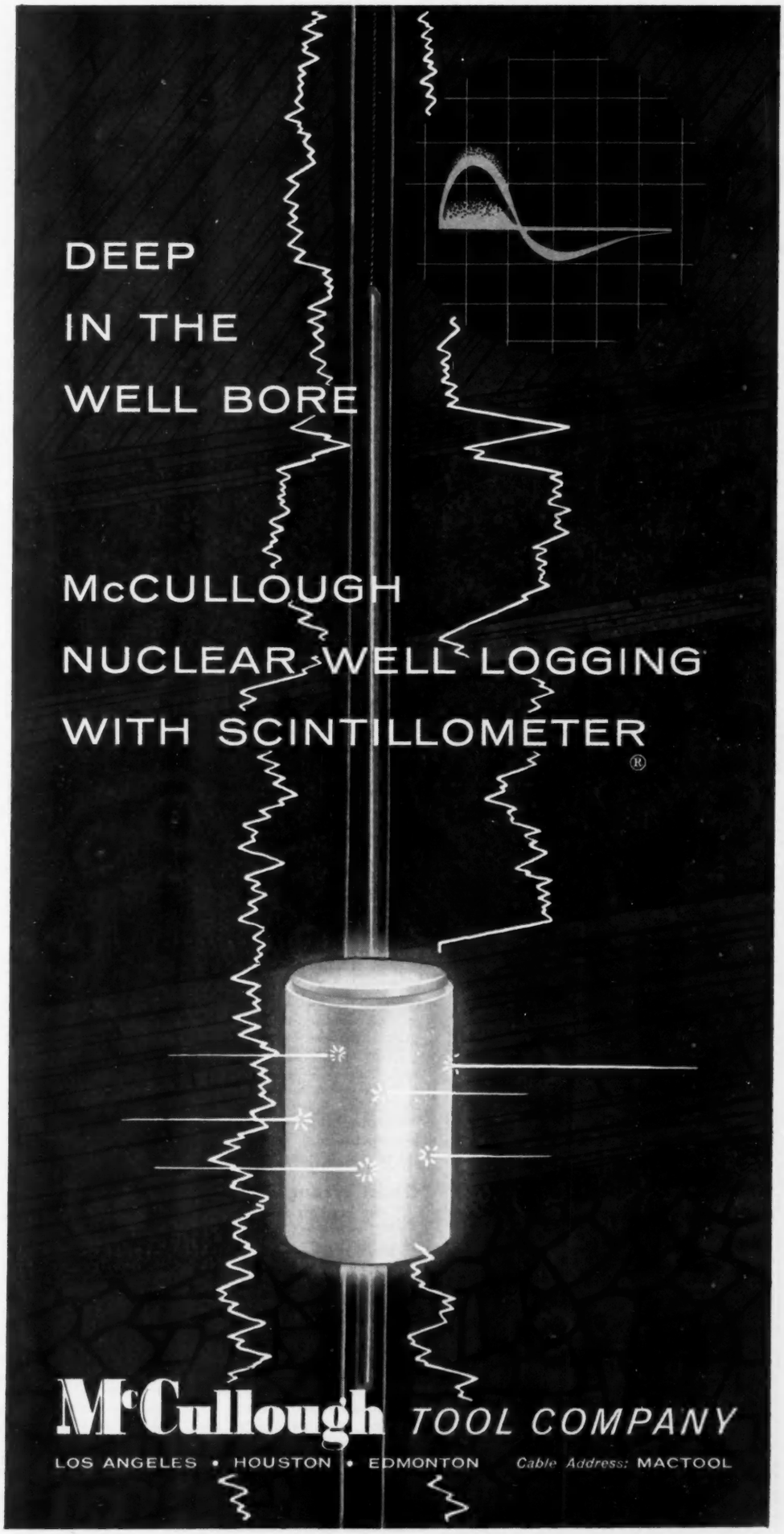
- ★ Rugged, shock-proof design assures dependable operation.

Call McCullough on your next job – you'll get the best logs you ever had – and you'll benefit by more accumulated experience in nuclear logging with the scintillation crystal than all others combined.



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Composite Catalog, Page 3400

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Doctor: "Your husband must have absolute rest and quiet. Here are some sleeping pills."

Wife: "Thank you, doctor, when shall I give them to him?"

Doctor: "You don't give them to him. You take them yourself."

Those Oklahoma Hills

On the outskirts of an Oklahoma town are six service stations in a row. Posted in front of the first is a large sign: "Last Chance to Buy Gas—the Next Five Stations are Mirages."

Speaking the Language

Alfred Smidlap was approached by a filling station attendant who said: "Boss, Dr. Tom Dooley is here with a flat tire."

Said Alfred: "Good! Diagnose the trouble as puncture wounds resulting in a prolapsed perimeter. Prescribe plastic surgery followed by a complete treatment of inflatus windus. Then charge him accordingly."

Progressive City

When a through highway is open it is probably because they are repairing a detour.

To Protect the Innocent

"Dad, why can't a man have more than one wife?"

"As you grow older, my boy, you will learn that laws are written to protect those incapable of protecting themselves."

Hair Today, Goon Tomorrow

"I always wash my hair in beer."

"Does that help?"

"No, but I've got the happiest dandruff in town."

It's a Joke Son

He: "Why are you letting me take you home?"

Beautiful One: "My father hasn't had a good laugh in years."

Thought for the Day

Do something to make people happy, even if it's only to let them alone.

Professional Success

Two doctors recently met for the first time since they were at college together.

"I'm specializing in nerve treatments," said one.

"And have you had any success?" asked the other.

"I should say so," was the reply. "When I had finished with my last patient, he asked me to loan him a $100."

Oops! Wrong Pew

Two bookies leaving a church service: "The word is 'Hallelujah,' stupid, not Hialeah!"

When the Spirit Moves Them

Then there is the story of the two little ghosts who drifted into a tavern and asked the bartender, "Do you serve spirits?"

Poor Eye-Sight

The worried leopard was consulting his psychiatrist. "I don't know what's the matter with me, doc," he said. "Every time I look at my wife I see spots before my eyes."

"That's only natural," answered the medic.

"But, doctor," explained the leopard, "She's a zebra!"

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Irwin Millner

Conspiracy Fugitive Sought By F.B.I. in Nationwide Search

Irwin Millner, also known as Irving Millner, Irving Milner, Fred Miller, and other aliases, is being sought by the Federal Bureau of Investigation for conspiracy to violate the Interstate Transportation of Stolen Property Statute.

Millner is alleged to have conspired with other individuals in the theft of geological and geophysical maps belonging to the Gulf Oil Corporation offices in Pittsburgh, Pa., and to have transported them interstate.

On Dec. 27, 1956, a Federal Grand Jury at Pittsburgh returned an indictment charging Millner with conspiracy and a warrant was issued for his arrest.

Reportedly, Millner has had considerable experience in the oil industry in the United States and Canada, and has participated in many oil promotions and drilling ventures in the past. He is believed able to converse with a great degree of persuasiveness and intelligence in this field.

Millner is described as a white male, American, born March 8, 1908 at St. Louis, Mo., heavy build, weight reported variously as between 275 and 375 pounds, brown eyes, grey hair, florid complexion. Millner combs his hair straight back and has a clean shaven, round face with double chin. He wears heavy rimmed glasses for reading and is said to have a very impressive personality.

Any person having information which might assist in locating this fugitive is requested to notify immediately the Director of the Federal Bureau of Investigation, U.S. Department of Justice, Washington 25, D.C., or the Special Agent in Charge of the nearest FBI Field Division.

Schlumberger Limited Acquires Interest in Computer Systems, Inc.

Schlumberger Limited has acquired an 80 percent stock interest in Computer Systems, Inc., of New York City. Under the stock acquisition plan announced by Pierre Schlumberger, president of Schlumberger Limited, and Robert E. Stern, president of Computer Systems, Inc., an amount of over $3 million will be invested in expanded production facilities, additional personnel and furthering Computer Systems' research and development program.

Stern says the change in ownership of Computer will not affect the present management or personnel. Computer, founded in 1950 as Mid-Century Instrumatic Corporation, manufactures analog computers and allied equipment.

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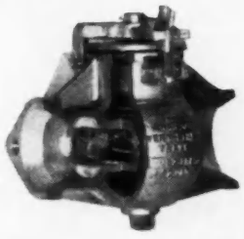

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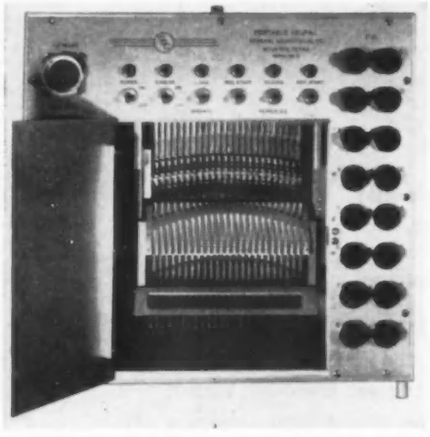
Threadless Fittings

This new threadless fitting needs no special tools for installation and no special preparation of pipe such as threading, grooving, flaring or soldering. Internal clutch ring and special rubber gaskets eliminate threading and grooving operations. The fittings and the pipe are salvageable and can be used over again. (Continental-Emsco Co. Supplements data on Pages 1365-1436 & 1437 & 1498, 1958-1959 Composite Catalog).

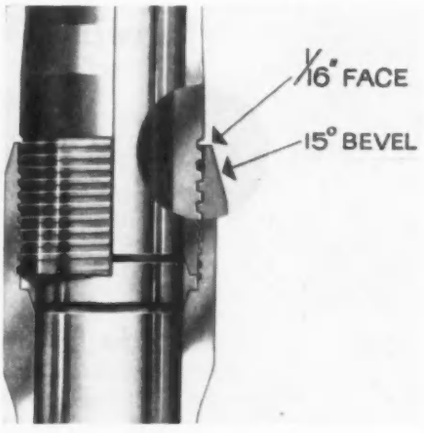
For more data, circle E1 on postcard



Portable Geopac Unit

A portable Geopac unit which allows the production of fully corrected seismic records in the field and provides extreme flexibility with respect to types of ground spreads has been developed. Economy, speed and precision are the chief features of this light, fully transistorized unit. Dimensions are only slightly more than a cubic foot and it weights approximately 50 pounds. Accompanying power and switching unit weighs only 45 pounds. Geopac uses a standard tape, 24½ inches long and 6½ inches wide. (General Geophysical Company).

For more data, circle E2 on postcard



Grayloc Tubing

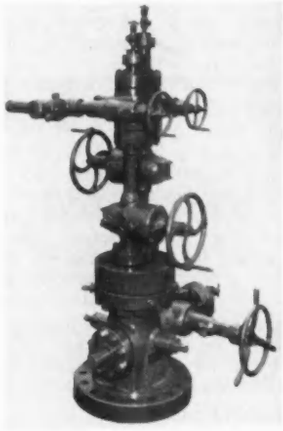
To facilitate running tubing in multiple completion wells, the box end of Grayloc Tubing now is being manufactured with a 1/16-inch bearing face and a 15-degree bevel. With the bevelled box end, Grayloc Tubing and an adjacent string of API threaded and coupled tubing can slide past each other freely. (Jones & Laughlin Steel Corp. Supplements data on Pages 2773-2792, 1958-1959 Composite Catalog).

For more data, circle E3 on postcard

New Pilot Mill

High speed, hardfaced pilot mills that end the need for costly inside cutting and jarring-out of stuck pipe section by section are now available. Each mill is capable of milling approximately 100 feet of wash pipe at speeds up 8 feet per hour with 4 or 5 feet being the average. "Zitco" hardfacing, a fragmented tungsten carbide material bonded in a special matrix, exposes the cutting surfaces of hundreds of tungsten particles for fast milling for the entire life of the cutters. (A-Z International Tool Company).

For more data, circle E4 on postcard



Crescent Flange Tree

A new flow control that features all the advantages of the time proven J-E Flow Control and has individual crescent flanges for dual trees has been developed. With Crescent Flow Control, new compactness and economy has been gained. Further elimination of connections guarantees leakproof operation. Manufacturer says it offers unmatched flexibility, simplicity and economy in that one valve in the dual hookup can be removed without disturbing the other. (Oil Center Tool Co. Supplements data on Pages 3737-3776, 1958-1959 Composite Catalog).

For more data, circle E5 on postcard

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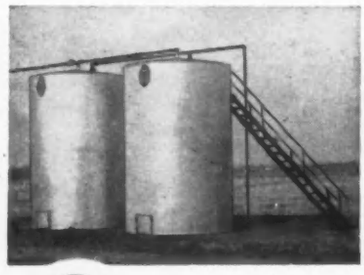
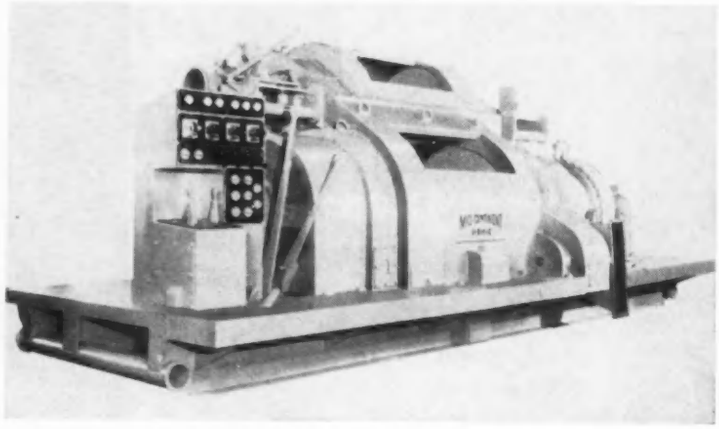
BAY CITY, TEXAS—J. P. Graham.....CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc....TE 5-7046, ZF 8-2023
CASPER, WYOMING—C. A. White.....3-5264
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUMA, LOUISIANA
Assoc. Eng. & Equip. Co.....UP 2-0347
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc.....5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqt., Inc.....CE 5-6770
LAUREL, MISSISSIPPI
Assoc. Eng. & Equip. Co.....8-7588
LIBERAL, KANSAS
Rainbo Service.....Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co.....PL 6-2530
MIDLAND, TEXAS
Lucoous Service & Eqpt. Co.....MU 2-1631
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
VIDALIA, LOUISIANA
Davis-Kemp Tool Co., Inc.....435
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc.....322-8584

For
DEPENDABLE
QUALITY



M & V TANK COMPANY
WELDED
LEASE
STORAGE
TANKS

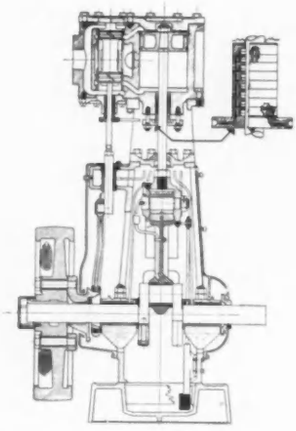
M & V TANK COMPANY
Wichita Falls, Texas
TANKS – TREATERS
SEPARATORS
Steel Fabrication
for the Oil Industry



New Big Drawworks

The new U-914-C, rated at 900 to 1,400 net input horsepower, is built for modern high speed drilling. Single package unit contains hoisting drum, transmission, rotary drive and auxiliary brake on a single skid. The rig, less auxiliary brake, weighs 45,575 pounds and is 10 feet wide over-all. It is equipped with self-equalizing, double adjustment, 52 inches by 10 inches main brakes coupled to a differential compound leverage. (Mid-Continent Supply Company. Supplements data on Pages 3401-3468, 1958-1959 Composite Catalog).

For more data, circle E6 on postcard



Floating Metal Packings

Specially designed floating metal packings are key components in a differential-pressure power unit which is being used in oil fields as a gas pressure reducing mechanism to convert normally lost energy into usable power. No gas is consumed or lost to the atmosphere, and the power produced is obtained without cost except for initial cost of the power unit. (The Garlock Packing Company).

For more data, circle E7 on postcard

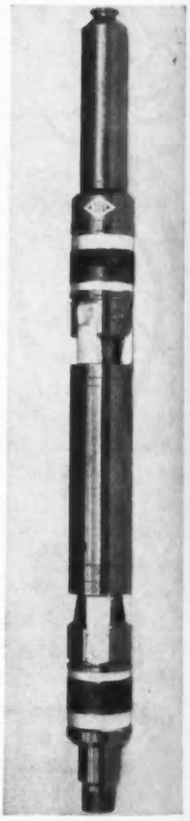
New Geophysical Tape

Geophysical Tape #350, produces a surface finish heretofore unknown in the geophysical magnetic recording field. Features include: natural lubrication, no surface lubricants to collect dust; surface impervious to moisture and fungus; extremely high temperature stability; freedom from drop out; unprecedented adhesion of oxide to base film; highest abrasion resistance. (Orr Industries).

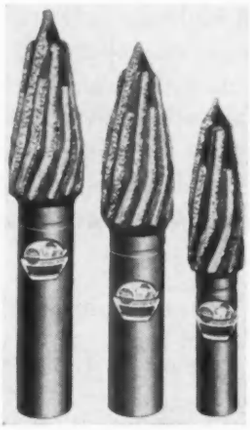
For more data, circle E8 on postcard

Hydraulic Set Packer

This is the Brown HS-16-1 Hydraulic Set Packer, which according to the manufacturer, has been proved in efficiency for single completions; dual completions with one zone through the annulus; and as the bottom packer for dual, triple, quadruple or quintuple parallel string completions. The packer is equipped with two seal assemblies to assure a positive seal. (Brown Oil Tool, Inc. Supplements data on Pages 893-944, 1958-1959 Composite Catalog).



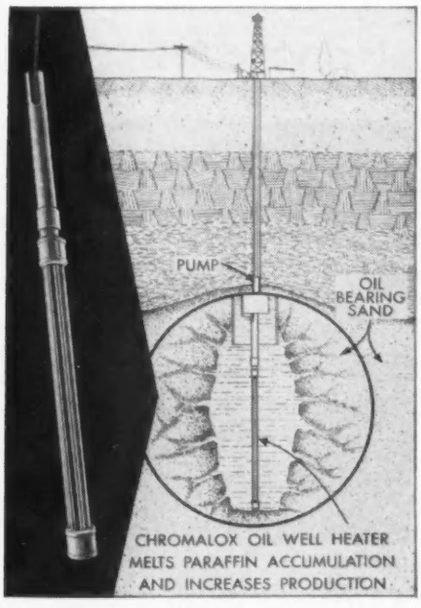
For more data, circle E9 on postcard



Redesigned Taper Mills

Servco taper mills have been redesigned for greater cutting efficiency. Dressed with Servoloy, a new patented method of utilizing tungsten carbide in drilling, milling and fishing tools, makes possible fast cutting speeds, according to the manufacturer. By suspending bits of carbide in a tough, elastic matrix, hundreds of cutting edges are always in contact with the surface to be cut. As particles are worn or torn away, new cutting edges are automatically exposed. (The Servco Company. Supplements data on Pages 4485-4504, 1958-1959 Composite Catalog).

For more data, circle E10 on postcard



New Electric Heater

A new Chromalox oil well heater is installed below the static oil level and pump. The heater forms the bottom end of the well pipe string and supplies heat at the sand face to melt paraffin accumulations and lower viscosity of crude. A cable splicing kit

Developed by Hycalog . . .

V-DOOR DRILL BITS PATENT PENDING CORE AND BUST TO ACHIEVE LONG UNINTERRUPTED RUNS

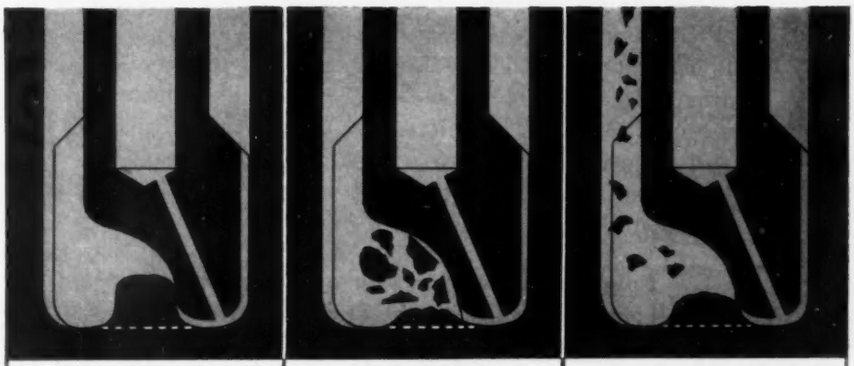
HYCALOG

Diamond drill bits were formerly handicapped in duration of runs . . . *and rate of penetration* . . . by their inability to dispose of cores formed at their centers.

In shales and other soft formations, the core twisted off and rotated with the bit.

In hard sands the core crushed the center diamonds, preventing further drilling.

BUT HYCALOG'S ENGINEERS have turned these handicaps into an advantage. Now, the V-DOOR bit, developed by HYCALOG, utilizes *controlled failing* of cores to achieve a faster rate of penetration . . . *and longer life*. HERE'S HOW:



The diamond surfaced center hole purposely cuts a cylindrical core. Valve action of core against bit reduces escape of fluid through the V-DOOR . . . forces it over the cutting surfaces keeping them thoroughly flushed.

Combination of bit design and hydraulic pressure breaks core into short segments. Then valve action is momentarily interrupted; high pressure fluid is released with a surge into V-DOOR port, forcing core fragments into discharge port.

Core fragments are flushed out of hole. With every revolution, the V-DOOR port sweeps bottom of the hole removing loose small particles, and eliminating necessity of regrinding.

Ask your HYCALOG rep to show you some performance records on the V-DOOR. He has a stack of them. *And also get the facts on* HYCALOG *well logging.*

Hycalog, Inc.

505 AERO DRIVE

SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND CORING • DIAMOND BITS • WELL LOGGING • CORE ANALYSIS

Congrats and $25 for this quip to M. H. Barber, Continental Oil Co., Big Spring, Texas.

"told him to pack the pump"

Whether it's running casing for surface hole, intermediate string, oil string or tubing . . . Lone Star Steel pipe is the brand Joe Roughneck counts on. Centrally located in the heart of the Mid-Continent oil producing area, Lone Star delivers API electric-weld casing, tubing and line-pipe on the double . . . in quantity! And, you can depend on Lone Star for quality as well as quantity. Our ultra-modern steel mill is equipped with the newest, most efficient tools in the industry. Rigid quality control is maintained from ore to finished product.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

© 1956 Lone Star Steel Company

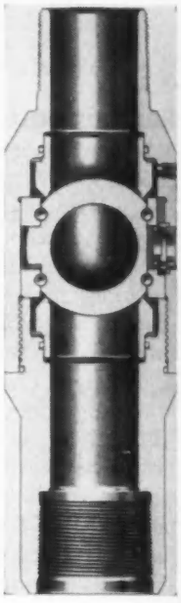
Lone Star STEEL COMPANY

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas
DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

simplifies lead wire connections and a threaded 2-inch upper stem attaches directly to end of pipe string. Capacity ranges from 5 to 20 kw, variable to meet available current supplies. (Edwin L. Wiegand Co.)

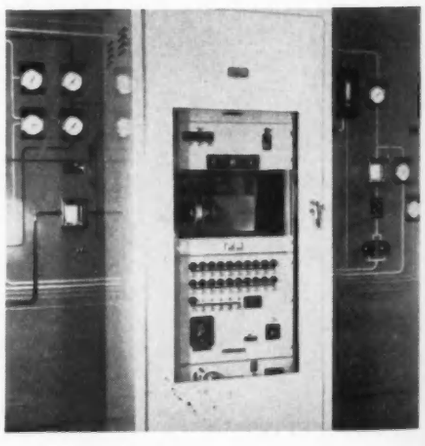
For more data, circle E11 on postcard

New Valve Design



A new ball-bearing-mounted spherical plug-type valve has been developed for a new line of kelly cocks and drilling safety valves. Features include compactness, great strength, positive sealing and unusual ease of operation under all pressure conditions. Enclosed grease-packed valves and bearing chamber protects the sealing surfaces and keeps all operating parts in top condition. (Hydril Company. Supplements data on pages 2549-2648, 1958-1959 Composite Catalog).

For more data, circle E12 on postcard

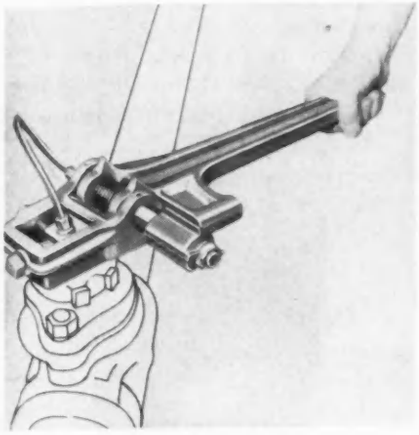


Automatic Programing

A completely automatic system for programing and recording oil well production and tests is available. This Production Operations Recorder system records data in either printed or punched tape form. Punched tape can be translated into visual form or

into typewritten form. Data can be automatically plotted into graphs. Components may be employed separately or as integrated parts of a single automatic POR control system. (Fischer & Porter Co.)

For more data, circle E13 on postcard



New LubeWrench

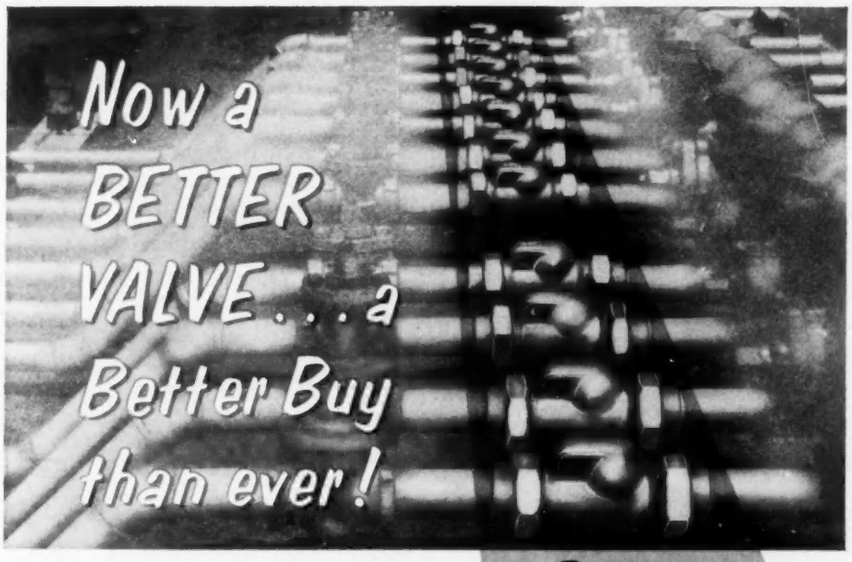
A new LubeWrench is available which saves costly plug valve repairs by automatically lubricating the valve each time it is operated. When the handle is pulled down to open or close the valve, a pawl on the handle turns the grease cap, pushing a predetermined amount of grease into the lubricating channels of the plug. Released, the handle returns to original upright position enabling the pawl to catch on next grease cap notch. (Harrisburg, Inc. Supplements data on Pages 2297-2299, 1958-1959 Composite Catalog).

Fort more data, circle E14 on postcard

Portable Seismic System

The SIE PMR-20 Portable FM Magnetic Recording System, is a 24-channel transistorized system complete in two compact, lightweight units. It provides high-fidelity frequency modulated recordings on standard SIE magnetic tapes from the output of standard geophysical amplifiers. Recording and playback modulation levels are read directly from a panel meter and all record-playback switching functions are accomplished from a single front panel switch. (Southwestern Industrial Electronics Co.).

For more data, circle E15 on postcard



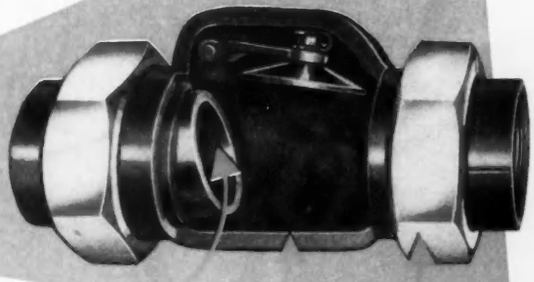
NEW DUCTILE IRON BODY

CATAWISSA "502" CHECK VALVES

1000 psi OWG 3000 psi Test
Sizes: 2" thru 4" N.P.T.

- COMPACT
- EFFICIENT
- ACCESSIBLE
- EASY TO INSTALL
- EASY TO INSPECT

for general flow line and pipeline use . . . horizontal or vertical



Here is one valve designed to take the rough handling necessary in most applications!

Metallographic structure of the ductile iron body resists leakage or seepage of liquids or gases.

FULL OPENING
DUCTILE IRON BODY
ASTM Spec. A-105, Grade 2, Forged Steel Union Ends

In production, pipeline or refinery use—the "502" has earned a reputation for long-life service and satisfaction . . . and now it's a better valve, a better buy than ever!

Catawissa "502" Check Valves withstand severe service conditions with built-in resistance to wear, shock or elevated temperatures. Their resistance to oxidation and a wide variety of corrosive media make them especially valuable where corrosion is a factor. Get the full story on all of their extra-value features!

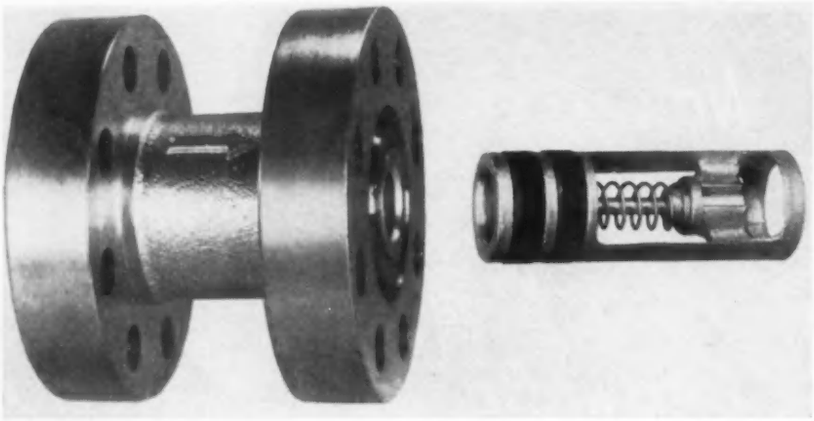
There's no need to "beat a path to our door" . . . just write for Catalog 58 or call your favorite supply store!

1917 42 1959
YEARS OF DEPENDABILITY

CATAWISSA VALVE & FITTINGS CO.

CATAWISSA • PENNSYLVANIA

For more data on advertised products, use Readers' Service Cards, last page.



New Check Valve

A new check valve for fill line or kill line has been designed to reduce abrasion. A straight-through flow minimizes turbulence, giving abrasive fluids little chance to damage the valve seat. Unit combines a simple, proven float valve with an API 1,500 Series, 10,000-pound test flange. Check valve is also available with threaded joints. (Texas Flange, Inc., Supplements data on Pages 4826-4827, 1958-1959 Composite Catalog).

For more data, circle E16 on postcard

FOR USE IN DRILLING OPERATIONS

Kirkose

SPANS THE WORLD

'KIRKOSE' SODIUM CARBOXYMETHYL CELLULOSE • USED ON A WORLD-WIDE BASIS FOR FLUID LOSS PREVENTION • AVAILABLE IN LOW AND HIGH VISCOSITY GRADES • SALT RESISTANT SUITABLE FOR BRINE MUDS AS WELL AS FRESHWATER MUDS

"In certain Countries of the world the use of S.C.M.C. for drilling operations is covered by patent rights, in connection with which we are empowered to grant licences. In sales for use in these countries (U.S.A., Canada, Mexico, Iran, Colombia, Iraq, Brazil, France) we pay a royalty to Drilling Specialities Company, Bartlesville, Oklahoma, of 7c. per lb. actual S.C.M.C., which is included in our selling price. In consequence, drillers in these countries are licensed to use our product for any drilling operations."

*CABLE 'KIRKSYL' BURY, ENGLAND. SAMPLES & FULL TECHNICAL LITERATURE WILL BE FLOWN OUT TO YOU ANYWHERE—IMMEDIATELY

Issued by the Chemical Division of KIRKLEES LTD., BURY, ENGLAND

New "Slant-Jet" Rock Bit

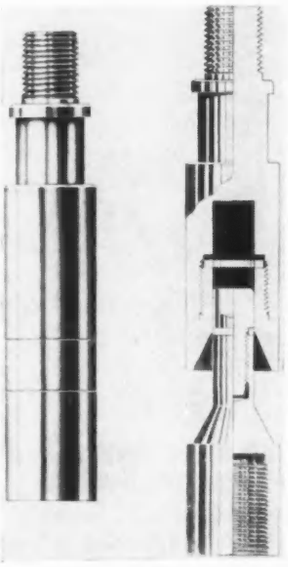
The "Slant-Jet" incorporates an entirely new hole flushing concept. Each nozzle is slanted so that the jet strikes hole-bottom immediately behind the cutter teeth of each cone. As a result, hydraulic flow of the jet is directed toward the cone teeth, cleaning them while simultaneously blasting loose bit cuttings with concentrated, angular force. With hole cleaning measurably increased, it is possible to record increased downhole penetration rates. (Chicago Pneumatic Tool Co. Supplements data on Pages 1261-1288, 1958-1959 Composite Catalog).

For more data, circle E17 on postcard

Portable Geopac Unit

A portable Geopac unit which allows the production of fully corrected seismic records in the field and which provides extreme flexibility with respect to types of ground spreads has been introduced. Economy, speed and precision are the chief characteristics of this extremely light-weight, fully transistorized unit. Dimensions are slightly more than a cubic foot and weighs approximately 50 pounds. (General Geophysical Company).

For more data, circle E18 on postcard



Swab-Line Safety Joint

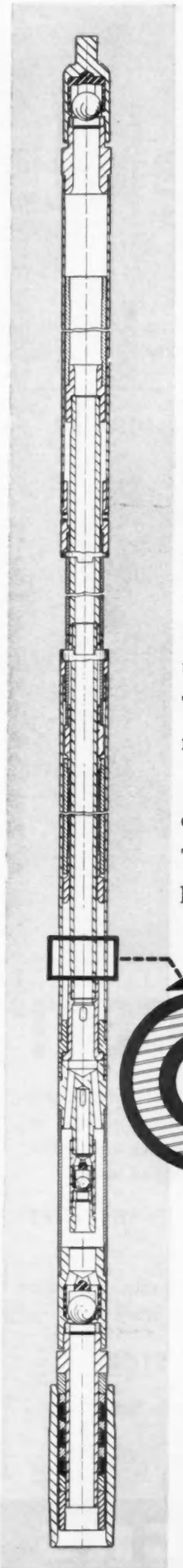
The new Raydon swab-line safety joint which provides a positive release point for disengaging wireline from swabs lodged in hole has been introduced. It releases at a predetermined load by means of a shear disc, available in 11,000 and 15,000-pound shear. Safety tool eliminates loss of line, overloading of equipment and lost time waiting for wireline cutting tool. After release, Raydon provides a fishing neck centered in the hole for easier recovery of swab. (Merla Tool Corp.)

For more data, circle E19 on postcard

Mobile Stratigraphical Rig

This mobile drilling rig is the latest addition to the Pilcon Range. Referred to as Pilcon, 2,500, it embodies all the features for giving reliable, trouble-free service in the field. All units are remote controlled from convenient panel at driller's position. The pneumatically operated controls are powered by twin compressors. Rig supplied complete, ready for drilling. (Piling and Construction Company Limited).

For more data, circle E20 on postcard



Get More Production with

PACIFIC'S DOUBLE BARREL

Insert Rod Plunger Pump

This particular design of Pacific's Type "D" Insert Rod Pump is one of the many tried, and is the direct result of engineering proved by actual field tests and operation. Over a period of years this pump was developed so that it could be removed on the rods for servicing ... yet produce at capacities equal to or greater than a Tubing Liner Pump. Many problems were encountered, but for each a satisfactory solution was found. The result is a most efficient and trouble free insert rod pump for handling large capacities.

The Type "D" Insert Rod Pump consists basically of two R. W. pumps in tandem. The upper pump is a Traveling Barrel Pump. The lower pump is a Traveling Plunger Pump.

WRITE FOR BULLETIN 204

Vertical cross sectional view of lower pump displacement chamber showing area which is between Inner Plunger Tube and Precision Tube. This area represents approximately 60% of the upper pump. Both pumps load on the up stroke and discharge on the down stroke.

PACIFIC PUMPS

Inc... A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA

Mid-Continent :
1358 So. Sheridan Ave., Tulsa 12, Oklahoma
Pacific Pumps of Canada, Ltd.,
Edmonton, Alberta

ONE OF THE DRESSER INDUSTRIES

PACIFIC®

DW-19

Epoxy Resin Adhesive

CONLEY WELD C 1—C 2 is an epoxy resin adhesive for bonding metal, wood, glass, ceramic, masonry, rubber, porcelain, glass fiber and other plastics. Contains no metal, is non-toxic, non-explosive and is resistant to dilute acids and alkalies. Easy application requires only simple visual equal-portion measuring and mixing (after sanding or buffing bonding area), according to the manufacturer. (Ed Conley Plastic Corporation).

For more data, circle E21 on postcard

BALANCE with JENSEN!

It's a simple one-man job to balance a well with a JENSEN Rotary Balanced JACK. Moreover, you're more likely to *keep* a well in balance the easy, accurate JENSEN way. Equipment above and below ground lasts longer and runs better on JENSEN-equipped wells.

There are 13 sizes in these famous orange and gray JENSEN JACKS —money-savers for wells to 7,500 feet.

JENSEN JACKS are built *to make wells more profitable*. For your information and your files, write NOW for the whole story.

STOCKED BY YOUR LOCAL SUPPLY STORE

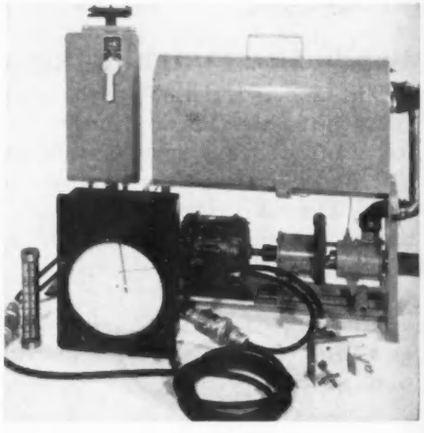
Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-D, Coffeyville, Kansas
Export Office: 250 Park Avenue, New York 17, N. Y. U.S.A.

JENSEN JACKS

New Logging Series

Two new loggers, Series V and Z, are now available. Series V are portable units, equipped for logging wells as deep as 5,000 feet. Can be furnished as Type PR (Potential and Single Electrode Resistivity curves) or as Type PR2N (potential, Single Electrode Resistivity, Long and Short Normal Resistivity curves). Series Z are heavier, non-portable for logging wells to 10,000 feet. Electric logs consist of Potential, two Normal and one Lateral Resistivity curves. (Well Instrument Developing Co. Supplements data on Pages 5104, 1958-1959 Composite Catalog).

For more data, circle E22 on postcard



New Mud-Weighing Device

This new mud-weighing device automatically indicates and records the weight of mud being discharged. The device also provides a continuous and uninterrupted safeguard against dangerously high or low weights, and it registers loss of circulation immediately. Charts and manometers register the loss of circulation immediately by dropping to a zero reading. (Bell Mudwate Corporation).

For more data, circle E23 on postcard

Literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL

Milling and Reaming Tools

A new 12-page brochure giving descriptions and use data for the complete line of A-Z International Tool Company's milling and reaming tools is available from all A-Z representatives.

For more data, circle E24 on postcard

Studs and Hex Nuts Folder

A new 4-page, two-color folder describing Republic Steel Alloy Studs and High Carbon Hex Nuts is available. Complete physicals are listed together with information on standard, special and stainless steel grades with recommendations for various service conditions.

For more data, circle E25 on postcard

Gas Lift Folder

A new folder from Merla Tool Corporation describes several types of installations in which Merla Types WF-3 and WFM-2 gas lift valves are presently being used to successfully produce stripper wells.

For more data, circle E26 on postcard

Well Logging Movie

A new full-color movie explaining in simple terms the complex techniques of well logging has been produced by Welex, Inc. The 22-minute film, entitled "The Oilman's Prophet, a New Look at Logging," is available on loan.

For more data, circle E27 on postcard

Insert Rod Pump

Bulletin 204 outlines the advantages of the improved Type "D" Double Barrel Insert Rod Pump manufactured by Pacific Pumps, Inc., a member of Dresser Industries. A cutaway drawing and a specifications chart are included in the bulletin.

For more data, circle E28 on postcard

Earthmoving Methods Movie

Earthmoving methods before the machine age and the story of earthmoving equipment from its inception to the present time are highlighted in the new 20-minute motion picture produced by Allis-Chalmers Manufacturing Company. The movie is available on a loan basis.

For more data, circle E29 on postcard

Oil States Catalog

A 24-page catalog listing all its products made for the petroleum industry is available from Oil States Rubber Company. Prices, instructions on how to order, and illustrations of products are included.

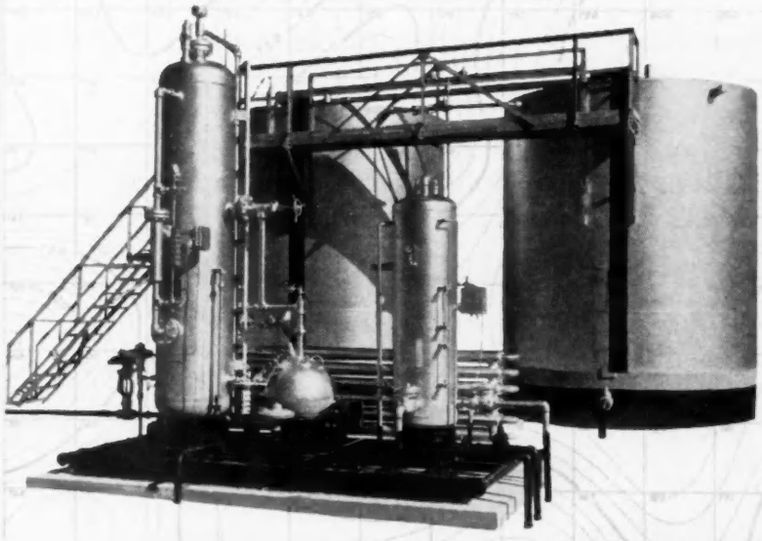
For more data, circle E30 on postcard

Specification Book

Specifications for oil field engines are given in a new book published by Engine Division, Caterpillar Tractor Co. The 12-page booklet contains five pages of condensed specifications for all models of Caterpillar diesel and natural gas engines. Specifications are given for hoisting, pumping and drilling duty, as well as engine-converter, marine and electric set data.

For more data, circle E31 on postcard

ON LOCATION FOR ONE BIG REASON . . .



Tysco Type CTS Cold Temperature Separator on stream at Texkan Oil Company's Unit "A" in the Whitted Field in Hidalgo County, Texas.

IT INCREASES HYDROCARBON RECOVERY!

Before putting their Unit "A" on stream, Texkan Oil Company, Dallas, Texas, wanted to be sure of getting maximum hydrocarbon recovery. After an investigation of many good cold temperature separators, they chose a Tysco Type CTS Cold Temperature Separator. The one unit that *gives* maximum hydrocarbon recovery.

The Tysco CTS Cold Temperature Separator installed for Texkan has a 7 MMCFD capacity. This unit is increasing recovery from Texkan's gas-distillate wells by as much as 15 per cent by recovering products that would normally be lost in the sales gas. *And*, the Tysco Separator will pay itself out in a minimum of operating time.

But increased hydrocarbon recovery is only one reason for selecting Tysco oil and gas process equipment. Equipment dependability and service after installation are also big factors. When you specify Tysco you get all three! Maximum recovery – Dependable equipment performance – On-time service.

Find out the advantages of using Tysco process equipment for yourself. Consult with a Tysco Sales Engineer before you put your next well on stream; there's no obligation.

TYSCO **TYSON SMITH CO.** ONE OF THE SMITH INDUSTRIES

8000 Hempstead Highway • Houston, Texas

SERVING INDUSTRY WITH QUALITY PRODUCTS, DEPENDABLE SERVICE.

Here is What Oil Men Say . . .

Twenty-four hours a day, around the world, oil men are using COMPOSITE CATALOG. Shown below are a few comments* (typical of thousands received) from oil men in every oil producing country of the world:

"This catalog is used daily by our staff in ordering replacement parts and new equipment."—Drilling Foreman.

* * *

"Engineering and purchasing would have a hard time without it."—Production Engineer.

* * *

"Your Composite Catalogs are and have been very useful to me on both foreign assignments and present job."—Drilling Superintendent.

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"It is of considerable value to me as a ready and constant reference to equipment available."—Division Production Superintendent.

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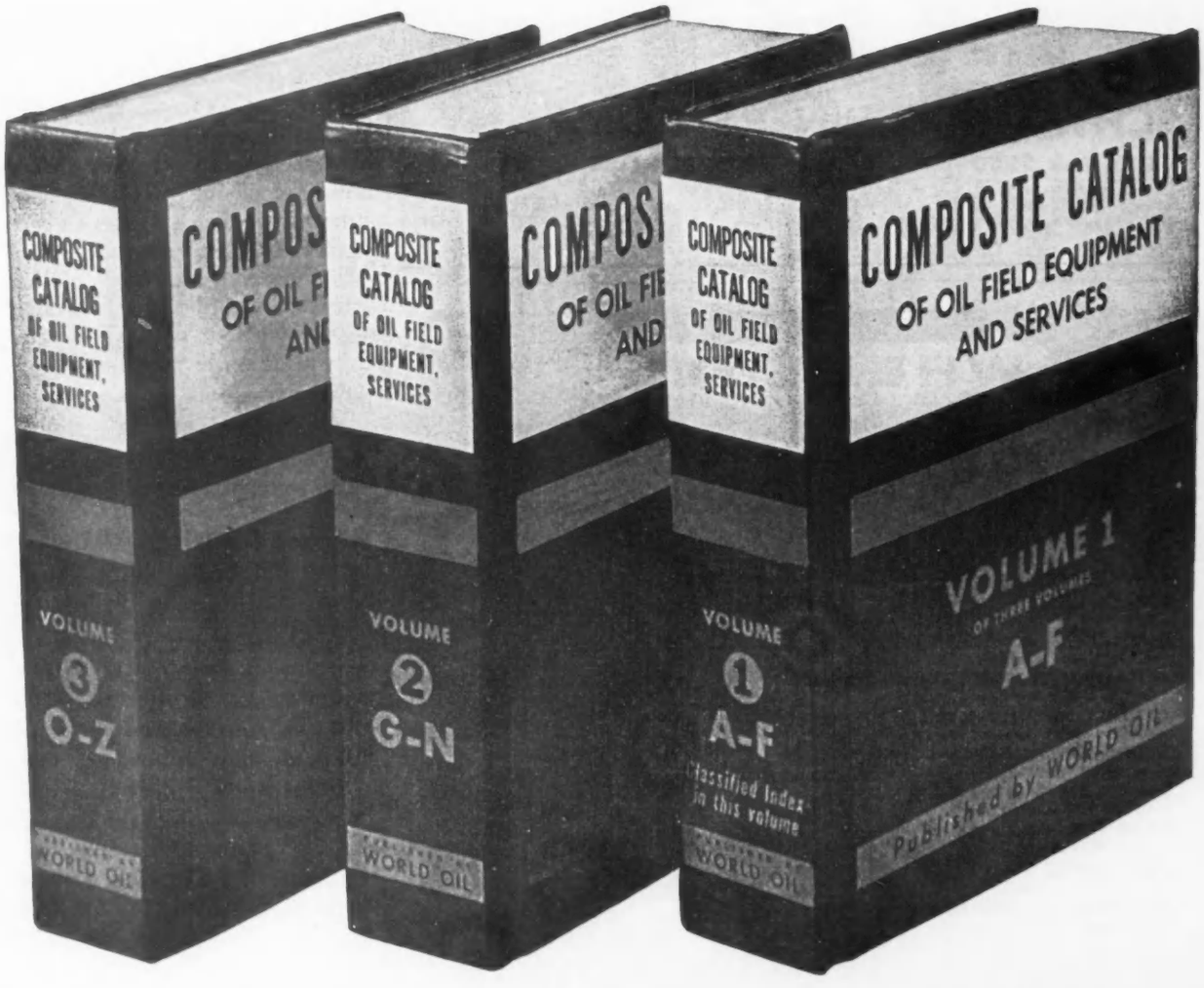

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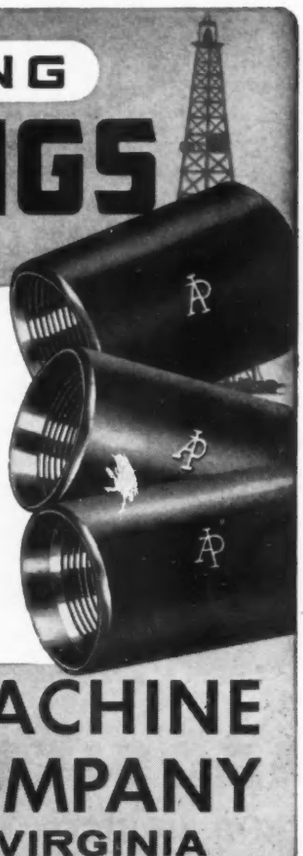

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Information on a standardized line of gearmotors, motogears and fluid drives has been combined into a new 48-page book and is available from Link-Belt Company. Book 2747 describes functions of various types of drives and provides detailed selection data, dimensions, overhung load ratings and mountings.

For more data, circle E32 on postcard

New Editions from API

American Petroleum Institute announces the availability of new editions on specifications and testing procedures covering oil well cements and cement additives The new specifications are contained in the Sixth Edition of API Standard 10A "Specifications for Oil Well Cements and Cement Additives."

For more data, circle E33 on postcard

Packaged Field Compressors

Clark Bros. Co., Division of Dresser Industries, announces the publication of Bulletin 158 which presents the advanced design and operating features of the Clark Model CFA Packaged Field Compressor Line. The bulletin describes the model fully with illustrations. Bulletin 171 describes the Model CFB, a two cylinder, heavy-duty addition to the line of packaged field compressors. Horsepower ranges from 200 to 350 bhp, with engines operating at a modern 1,000 rpm.

For more data, circle E34 on postcard

Record Depth Wells

The National Supply Company has issued an illustrated leaflet entitled "How Deep Can a Well Be Drilled?" The leaflet gives particulars on all world's record depth wells below 15,000 feet. Also contains pictures of the six wells that established successive world's depth records since 1947.

For more data, circle E35 on postcard

Fracturing Service Folder

A comprehensive folder listing Dowell fracturing services for the oil industry is now available. The folder presents technical information on each individual fracturing service and describes their application. Also included is a list of Dowell auxiliary services and products to improve fracture results.

For more data, circle E36 on postcard